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Unemployment among the Educated

(Continued from the June issue)

The Reorganization of the Educational System

THIS is largely a question of the reorientation of our educational aims and policies so as to effect a radical change in the structure, contents, and methods of our national educational system. The character, quality, and volume of supply of the products of our educational factories in their different stages and grades must be so regulated as to be in equilibrium with the demand for them arising out of the progressive development of the different departments of our national life. Such reorientation, it is obvious, must be planned on a long-range basis so that, simultaneously with the growth of demand for different kinds of abilities and talents, there may be a corresponding growth in their supply. In the framing and carrying out of such a plan of educational reconstruction, the principal aim that should be kept steadily in view is that the products of our educational institutions must fit in with the requirements of all-round economic and social progress of a great, modern nation.

Now, although there are still great differences of opinions on matters of details, we believe that there is a substantial measure of agreement among all sections of the public that the main principles of educational reconstruction should be as follows :

Primary Education

Here the principal requirement is the establishment of compulsory, universal primary education on a really effective standard and with a practical, industrial, or agricultural bias. It is further recognized on all hands that the period of schooling at the primary stage should be extended from four to six years so that literacy might be permanent and effective.

In this connection it is important to note that the establishment of universal primary education will absorb many thousands of educated young men and women In August last, the Department of Education, Government of Bengal, published some valuable statistics on primary education, on the basis of which we can form some definite idea of the scope for employment that will be found in the expansion of primary education. At present, there are some 52 lakhs of boys and girls of the school-going age (6-10 years) in Bengal. Of these, 23 lakhs are actually reading in 64,000 schools, manned by some 80,000 teachers. The Government are of the opinion that a more rational and economic distribution of the schools will enable us to give effective education to these 23 lakhs of juvenile scholars in 16,000 schools to be staffed by some 64,000 teachers, each school to cost Rs. 65 in salaries. Even on the basis of the Government plan, which, however, is subject to many criticisms on principle and details, it is found that, in order to enable the remaining 29 lakhs of boys and girls of the school-going age to be at school, we have to provide at least another 20,000 schools and 80,000 teachers. But if, as has been rightly suggested by the Sapru Committee, the schooling period is raised from 4 to 6 years, each school must have six teachers, so that the total number of teachers required would be 2,16,000, which will mean an addition of 1,36,000 teachers to the estimated number of 80,000 teachers who are already in employment.

Since all are agreed that an efficient system of primary education is a pre-requisite of scientific economic organization and sound political progress, it is highly desirable that the establishment of universal primary education should be taken in hand as an urgent item of national reconstruction, thereby creating additional employment for some 1,36,000 teachers in a single province alone. If we assume that the statistical position regarding primary education in British India as a whole is more or less the same as that in Bengal, it can be expected that the mere expansion of primary education on a universal basis will create suitable employment for about 7,00,000 young men and women as teachers in the whole of British India.

Secondary Education

This is to be so reorganized as to include four different types of institutions, which will offer scope for diverse types of ability, talents, and temperament. These four types are to be *(a)* arts and science, *(b)* agricultural, *(c)* commercial, and *(d)* industrial. As a result of this diversification of secondary education, it is expected that a large number of students, unsuited by ability or temperament for university education, will be automatically diverted into industrial, commercial, or agricultural occupations or into subordinate services under the Government.

University and Higher Technical Education

This also should branch off into several specialized types such as *(a)* arts and science, *(b)* law, *(c)* medicine, *(d)* engineering, *(e)* technological, *(f)* agricultural, *(g)* commercial, etc.

As the Sapru Committee rightly points out, if primary education is extended and tinged with a practical bias, and if secondary and higher education is diversified, a large number of boys and girls will enter into various occupations or technical institutes after the completion of the primary or secondary stage. Consequently, the flow of ever-swelling numbers into the universities will be automatically reduced. We are, therefore, at one with the Sapru Committee in the view that it would neither be desirable nor necessary to restrict admission to the universities through some arbitrary standards of artificial methods.

Broad Lines of Reconstruction

In an earlier section of this article, we have indicated in a general way how the bases of the nation's economic life can be strengthened by undertaking large-scale reorganization and reconstruction in the departments of education, public health, agriculture, industry, and commerce. It is neither possible nor necessary for us in this place to go into the details of all the possible, urgent items of reconstruction work. But we can show, by a few concrete instances, how these development will satisfy the double test of creating good employment for our youths and at the same time increasing the income of the nation in a substantial measure, directly and indirectly.

Public Health

It is nowadays generally recognized in all civilized countries that there is a close connection between public health and economic progress. The All-India Medical Research Workers' Conference, held in 1926, expressed the opinion that in India every year there are two to three *million* deaths, caused by preventable diseases; that, due to malaria, kala-azar, and other diseases, there is a loss of physical efficiency estimated at some 50 p. c. on the average; that the number of working days lost thereby by every individual on the average is from two to three weeks; and that the loss of national income caused thereby amounts to many hundreds of crores of rupees. And this expert opinion is confirmed by the personal observations and experience of every one of us in Bengal. There is a tremendous amount of wealth also wasted upon the rearing of those hundreds of thousands of infants and young persons who die before they begin to contribute to the national income and also upon the maintenance of those who become prematurely old and infirm. It is, therefore, clear that the investment of a large part of our national income on the improvement of public health by preventing waste and increasing efficiency will add largely to our national dividend, and thus become remunerative in the highest degree. Besides, millions of individuals will derive a considerable gain in terms of health and happiness, which can also be regarded in itself as one of the highest purposes of national reconstruction. In our opinion, therefore, public health and primary education should be regarded as basic factors of national economic progress, exactly in the same way as key industries.

Consequently, if a properly thought-out scheme of rural medical aid and sanitary improvements is carried out so as to cover the vast countryside of India, it can give employment to many thousands of doctors and sanitary inspectors. There are over 6,00,000 villages in India, and if a subsidized medical practitioner is appointed for each group of 5 villages, and a wholetime sanitary inspector for each group of, say, 20 villages, it will mean employment for some 1,50,000 young men. Along with these two groups of persons there should also be appointed, for each group of 10 villages, a trained midwife on a subsidy basis, with a view to making a serious assault on the terrible wastage caused by the high rates of infantile and maternal mortality.

Agricultural Development

Many competent authorities are of opinion that the root cause of middle class unemployment in India is insufficient development of industries. The following table shows the percentage of working population in different professions in a few civilized countries:

Country	Agriculture	Industry & Mining	Trade & Transport	Liberal Professions
India	67.2	10.2	8.6	1.5
Britain	7.1	47.2	20.7	4.4
U. S. A.	22.0	31.7	24.5	7.0
Canada	31.2	24.9	17.7	6.2
Germany	30.5	41.3	16.4	4.1
France	38.3	33.3	17.0	3.6
Japan	50.3	19.5	20.2	..

It will be clear from the above table that in India the profession of agriculture is overcrowded.

It is also a well-known fact that this predominant industry of our country is nowadays in a poor and decadent state. Absence of cheap and adequate financial facilities, lack of organization, fragmentation of holdings, primitive systems of transport and marketing, the existence of a host of exploiting middlemen, ignorance of modern scientific methods and inability to adjust supply to demand—these are some of the main defects from which our vast agricultural industry has been suffering for decades past.

> "With such terrible disabilities it is astonishing that agriculture survives. It does so only because the cultivator exists on very little more than the food he produces. It will not continue to exist in the world markets for raw products in competition with other countries, better equipped and organized, unless radical and bold reforms are undertaken . . . . . . Agriculture at present does not pay."

If at the same time we remember that the average agricultural holding per cultivator in India is 5 acres* to Britain's 55 and U. S. A's 157 acres and that the average production per agriculturist is only Rs. 195 to Britain's Rs. 2200 and U. S. A's Rs. 1930, we will understand why educated young men show so much reluctance in taking to agriculture in spite of the continuous advice from those better placed in life to "go back to land".

It will be outside the scope of our subject to discuss the problem of rural prosperity, which can only be restored effectively by a large-scale migration of the present rural population into industries or into undeveloped areas. A good deal, however, can be done in the way of placing Indian agriculture upon a strong footing with proper financial and scientific equipment. During the last thirty or forty years, due to the application of the discoveries of modern biological and physical sciences, the agricultural industries all the world over have been passing through a revolutionary readjustment. In consequence, the older countries like India which are still following ancient and inefficient methods are being rapidly ousted out of the world markets, and even being defeated in the home markets. For example, what could be more strange than the fact that Bengal, with its 23 million acres of rice fields, cannot support its own population, but must import a million tons of rice from abroad!

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*According to 1921 Census in Bengal it is 3.1 and in U. P. it is 2.5.

Indian industries suffer from the great handicap that the great majority of our countrymen live at the bare margin of existence, and there is no purchasing power to buy the products of modern industries.

It is easy enough to see that, if the per capita income of the vast multitudes of the peasantry can be raised even by Rs. 5 by preventing wastage, increasing productive power, providing better financial and marketing facilities, and if this additional income be available for purchasing the products of industries, our industries will have a great and growing market opened at their very door.

Now, agricultural development in India, apart from the question of "per capita holding," is largely a matter of such organization as can be immediately tackled. If the villages in groups of 5 each are organized into agricultural associations on the co-operative principle, each association employing an expert trained in the principles and methods of modern agriculture, the income of the peasants can be increased in a considerable measure. And in this task of agricultural reorganization, more than a hundred thousand educated persons can find profitable and honourable employment. In the beginning, of course, these agricultural associations will have to be subsidized by the Government and the local authorities. But ultimately, like the famous agricultural associations of Japan, they are expected to be financially self-supporting.

Or, again, let us consider the question of agricultural finance. The amount of agricultural debts in the country may be estimated at 1,000 crores in round figures. The rates of interest paid vary from 25 to 300%. As has been demonstrated to a certain extent by the co-operative movement during the last 30 years, the burden of interest on agricultural debts can be reduced by at least 50 per cent through the organization of co-operative credit societies. The minimum amount of savings on this account will be over 100 crores. Now, if the 600,000 villages of India are organized into co-operative credit societies in groups of 2 or 3 villages each, some 200,000 or 300,000 educated persons can be employed as managers, clerks, auditors, and inspectors of these societies.

Small-scale Cottage Industries

It is a commonplace that in a country of small peasantry, where agricultural work, depending as it does on the fluctuating, seasonal rainfall, can provide occupation for barely 4 or 5 months in the year, cottage industries are essential as subsidiary occupations which give off-season employment, and thereby augment the meagre and inadequate income of the peasants. Japan, Germany, Switzerland, and many other countries have, by deliberate State policy, fostered numerous cottage industries in order to strengthen the position of the peasants.

India has been the home of cottage industries from very early times. But these cottage industries were largely based on a self-sufficing system of village economy, where the caste rules regulated the standard of craftsmanship and fixed the remuneration in kind. The artisans, being accustomed to an assured clientele in the self-contained villages, gradually developed an extremely narrow and conservative outlook. Due to the influence of caste traditions, they could never see the importance of adapting themselves to the new environment and the changed tastes and requirements, brought about by the development of transport and communications and by contact with the West. Consequently, they fast succumbed to the competition of modern large-scale industries, equipped with large financial resources, strong organization, and thoroughly scientific marketing methods.

Now, in devising schemes for the revival of these cottage industries, it will be well for us to bear in mind once for all that it would be an act of tremendous folly on our part to ignore the tendencies of the scientific developments of modern times. From the technical and commercial points of view industries may be broadly divided into two classes: (*i*) there are those industries which turn out vast quantities of mass products that satisfy the common, elementary, essential wants of physical existence, such as plain clothing, and (*ii*) those which produce the instruments of large-scale production and transport, such as iron and steel, railway materials, machinery, etc. In the same class may also be placed those industries which produce vast quantities of homogeneous, semi-manufactured commodities, such as leather, cloth, yarn, etc. They satisfy the standardized requirements of modern mass demand. These industries, in order to be technically and commercially efficient, must be established on a large scale.

In the second class are to be included those industries which produce such goods as satisfy the demands of fashion, of highly individualized consumption and of local customs and group tradition. They generally supply what might be called the non-essential wants of people. And it is in this sphere of production that small-scale industries can be expected to hold their own under modern conditions. Articles of clothing of various textures, designs, dyes, and colours, chinawares, toys, and other fancy goods, and a hundred and one requisites of modern toilet may be cited as outstanding examples of goods that offer an appropriate field for the cottage industries.

It is not necessary for us to discuss in detail all the aspects of the reorganization of cottage industries. Briefly, we may state that the artistic training of the craftsmen at schools of arts and crafts, the supply of new designs and models by artists, co-operative organization for the supply of capital and purchase of raw materials, proper advertisement through salesmen, emporia, fairs and exhibitions, supply of cheap modern tools and implements, and the provision of electrical power are some of the chief methods by which the cottage industries can be placed on a solid foundation. If efforts are made on a national scale in order to resuscitate the more important cottage industries of India and to create new ones in response to changing demand, a vast field of profitable employment can be created in the country.

In connection with the reorganization of agriculture and cottage industries, however, there appears to be in certain responsible quarters a grave confusion of thought, which it is our duty to dispel. It is thought by the Government as well as by many of our foremost leaders that a good solution of the problem of the educated unemployed would be to settle these persons on the land as agriculturists or to train them up as artisans and handicraftsmen. But there are at least two important reasons on account of which we believe that such a notion is exceedingly ill-founded and that such a move will lead us nowhere.

Firstly, there is far too much of poverty and unemployment among the peasants and artisans themselves, and consequently, the resuscitation of agriculture and cottage industries must be meant primarily for the benefit of these classes of workers. Secondly, the employment of educated youths as artisans or peasants can neither give proper scope for the exercise of those special talents and faculties which are their main assets, nor satisfy their deep-rooted emotions and aspirations. Accordingly, our definite view is that, in the scheme of economic reconstruction, the role that can be appropriately assigned to the educated men would be that of directors, organizers, advisers, managers, clerks, inspectors, etc. As an Indian economist recently put it, "the best of all conceivable policies for the Government to follow would be to harness the vigour, training, and sentiments of the educated youths to the task of guiding and leading the peasants and artisans in matters of agriculture, co-operation, public health and education."

Medium-scale and Large-scale Industries

The reports of the Industrial Commission of 1916-18, the Banking Enquiry Committee of 1929-31, the Indian Fiscal Commission of 1921-22 and the numerous volumes published by the Tariff Board during the last 12 years are rich with many concrete suggestions as to the ways and means by which medium-scale and large-scale industries can be developed in this country so as to create new and varied fields of employment. Briefly speaking, an energetic policy of discriminating protection through duties and bounties, a systematic preference for Indian goods in the matter of stores purchase, adequate provision of technical education, the establishment of an up-to-date system of apprenticeship, starting of industrial finance corporations under State ownership or with State guarantee of interest on capital or debenture, supply of expert advice, adoption of the modern system of salesmanship, encouragement of banking development, drastic revision of the law relating to banks and joint-stock companies, and in particular, a thorough overhauling of the managing agency system, and the supply of accurate and sufficient economic intelligence and statistics are some of the essential pre-requisites of a rational and rapid industrial development. Success in this field will be rapid if only there is a close co-operation between the Government and the people. A Government which is interested only in keeping its head and balancing its budget richly deserves the epithets "wooden and anti-diluvian," given to it by the late Mr. Montague. A people whose conservatism cannot be overcome by modern knowledge, whose most obvious characteristics are lack of enterprise and mental inertia, cannot be expected to survive long. We would, therefore, urge that these attitudes which are fatal to progress should be immediately discarded. And in place of the policy of casual, halting, and piece-meal development of industry that has been followed in the past, there should be adopted a comprehensive national plan of progressive industrial development—key industries (*e.g.*, iron and steel, engineering, railways, ship-building, mercantile marine, heavy chemicals, coal, oil, and hydro-electric power) *on the one hand, and the fairly efficient* consumption goods industries (textiles, leather, vegetable oils) on the other, at the first stage, the less efficient and the more complicated industries at the second stage, and so on.

The development of medium-scale and large-scale industries, too, will certainly absorb a large number of educated persons as managers, technicians, clerks, accountants, auditors, salesmen, etc. But what is vastly more important in our view is that a rapid and comprehensive industrial development by substantially increasing the average per capita income of the common man and common woman will leave a large and growing surplus in their hands, which will be available for the purchase of a great variety of commodities, personal and social services, and many of the good things of modern civilized life. And this, in its turn, will stimulate the growth of new types of industries, occupations, and nation-building services, and thus create employment for a great and growing number of educated men and women. It is only by such a radical and comprehensive, economic and social reconstruction, which will embrace all the important departments of national life, that we can hope *to lay well and deeply the foundations of the Greater* India to be, and incidentally, also solve on a permanent basis the acute and tremendous problem of the unemployment of thousands of our strong, vigorous, patriotic, and educated youths, by ensuring to them the right to work and serve, the right to live, and the right to be happy.

A Rock Storage Oven for Electrical Heat

When the decision was made to electrify Manson City, the contractors' camp at the Grand Coulee Dam Site, opportunity was given to the State College of Washington to use it as a field laboratory and to carry on an extensive series of studies relating to the use of electricity for domestic heating. One house was selected to study the feasibility of heat storage. The basement was 20 ft. by 28 ft. and a system of ducts and registers was laid out similar to that which would be employed in a warm air furnace installation. In place of the furnace, however, an insulated brick oven was built, about the same size as a domestic furnace. The space inside the oven was filled with granite boulders ranging from 3 lb. to 60 lb. in weight. The useful heat capacity was figured to be one million B.t.u. at 600 deg. with an additional 690,000 B.t.u. available by raising the temperature to 900 deg. Provision is made for inserting electric heater elements through a duct underneath the mass of rock so that, when electricity is on, the natural air circulation will carry away the heat and communicate it to the bricks in the oven. Arrangement is made so that cold air from the rooms is mixed in the right proportion with the hot air from the oven for the house heating. Forced circulation is used, by an electric fan. To keep the oven at 555 deg. 2.65 kw. was required, which cannot all be attributed to losses, as this heat escaped into the basement. In the tests made, it was revealed that the heating elements used were too small and that greater insulation should be built into the oven. There is pointed out that this may be a method for smoothing out the 24 hour load curve of utility power systems.

Jour. Frank. Inst., May, 1936.

A new Form of Earth Leakage Protection

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It is unfortunate that several of the most useful insulators in modern electrical practice are of organic origin, which fact sets a definite limit to their useful life. If insulation could be made permanently faultless there would be no need for the many and varying forms of earths leakage protection adopted to-day; we have to face the fact, however, that deterioration of most insulators is certain, and sooner or later leakage will take place.

The trend of present-day regulations and control of supply to consumers' premises is to prevent leakage potentials reaching a value likely to be dangerous to human life. It is interesting to compare this with early editions of regulations, which apparently were more concerned with the safety of property—apparently menaced with fire—and is no doubt explained by the fact that more and more electrical apparatus is being placed literally in the hands of the public, whilst the rising popularity of the more lethal alternating current supply plays its part.

Overload protection has now reached a high level of efficiency, whether applied by means of circuit breakers or the more common fuses. Leakage protection, on the other hand, remains in a very elementary form, usually dependent upon the satisfactory functioning of the overload protective devices under conditions which make this satisfactory operation problematical.

The matter of adequate protection against leakage potentials that must sooner or later occur upon all electrical installations has never received the attention that it deserves in England—or, at least, not until the last year or so. It has never been divorced from the twin problem of overload protection, although it will be seen that there is no real connection between the two. They have become associated by reason of the one protective device having to function under the two widely differing sets of fault conditions, which may, or may not, be in existence together. Put in few words, leakages have not been isolated until they have also become overloads.

The commonest form of protection against high leakage potentials is, of course, earthing, and this is the only form that I propose to discuss at any length. To be effective in protection, earthing must fulfil three definite and fundamental requirements; (1) the earth circuit, including the earth electrode, must possess negligible impedance; (2) the earth circuit must be maintained intact throughout the life of the installation; and (3) the circuit fuses must be correctly adjusted. All appropriate regulations seek to ensure these essential requirements by various means, and in the town or city it is usually a simple matter to fulfil the most important of them by utilizing the extensive underground water-supply systems as the earth electrode. Not only does this step ensure a low resistance path for a leakage current, at negligible cost, but to some extent it determines the path of the current through the earth itself, thus preventing the appearance of the dangerous potential gradient so common with other forms of electrode, and which has been such a prolific cause of accidents.

Even so, no effective means have yet been devised whereby any failure of continuity in the earth circuit, or the introduction of resistance, may be immediately indicated, and until this can be done no great amount of reliance can be placed upon solid earthing systems. The treacherous nature of this form of protection is too well known to the practical installation engineer to need further emphasis, and there is no means of adequately testing the earth circuit. It is, to my mind, almost ludicrous to test an earth circuit designed to carry 50 or 100 amperes with anything less than this current, but most engineers are content to test for continuity or resistance with a current of a few amperes only. Tests, to be effective, must be at least to approximate working conditions, or higher.

A NEW FORM OF EARTH LEAKAGE PROTECTION

In country districts, now providing such a wide field for the extension of electrical services, the first essential for sound earthing is absent. We have not the gratuitous provision of a low resistance earth electrode such as we have been used to finding in towns, and generally even underground cable networks are absent. Attempts are therefore made to substitute these by means of buried plates, or driven pipes or rods, all of which are much inferior to the water system, but just how much inferior is not generally realized. In these attempts to secure as low resistance as possible great expense is often incurred—by the supply authority in connection with the earthing of the neutral point at sub-stations, and by the consumer for the effective earthing of his apparatus. In regard to the latter, it is no uncommon thing for the cost of an earthing electrode to approach, and has been known to surpass, the cost of the installation itself, and there is no sort of guarantee that the electrode secured at such heavy cost will remain an efficient one for more than a few months.

I have at various times published results of tests on several types of earth electrodes in the English technical papers, but with the exception of the tests carried out by the National Physical Laboratory, and given as an appendix to this article, I cannot claim that the figures are authoritative. I therefore propose to quote from the most recent report of the Chief Electrical Inspector of Factories, detailing tests made with a certain supply authority in Scotland, and of which I have some knowledge. It is stated, Page 15—

> "Among the problems associated with the development of our electricity supply in rural areas is that of securing earths of sufficiently low resistance. A series of tests made on a number of systems and over wide areas have illustrated the difficulty of obtaining adequately low values, either for connections for line protective gear or for those required for neutral point earthing. The problem has assumed an importance such as to prompt a number of undertakings to institute research into the whole subject, and the results communicated to this Department are of interest as showing (1) that the means of earthing ordinarily adopted, and whose adequacy is often taken for granted, may be quite ineffectual; and (2) that conditions may be considerably improved by the application of certain measures and resort to protective apparatus of a novel character."

After detailing the steps taken, at great expense, in order to attempt to improve the ordinary earth electrode by means of periodical saline treatment, generally resulting in complete failure, the Report goes on to say—

> "For the more important sub-stations the undertaking has in some cases been able to find water pipes, often at considerable distances, but without which it would have been unsafe to give a supply in any way approaching the designed output of the sub-station. In other cases, by the use of brine treatment or the sinking of earth plates near streams—which may be remote from the sub-station—earth resitances have been reduced to an approximate value of 15 ohms, enabling supplies to be given for lighting purposes only."
>
> "The conditions noted above have led to the consideration of the use of a supplementary earth leakage device for connection between the neutral conductor and earth."

The novel apparatus referred to was developed in Germany some years ago, and has recently been introduced into England. Rural electrification was commenced on a large scale in that country some thirty years ago, and to-day some 80% of farms are supplied with electricity, a figure approached by no other country. Quite early in this development, however, it was found that the ordinary methods of earth leakage protection, including multiple earthing of the neutral, were quite ineffective, and a series of accidents to cattle and to a lesser degree to human beings, caused something of a reaction against rural extensions. In the words of a director of the largest supply undertaking in Germany—"We were forced to devise improved methods of protection for man and beast in order to overcome this disagreeable reaction."

The apparatus that will be described was first put into use in Germany about ten years ago, and was made compulsory in certain areas about two years later; it is now universally used throughout rural areas, and in view of its complete effectiveness, is coming into general use where hitherto earthing difficulties have not existed. A demonstration of the apparatus in this country some three years back has resulted in a demand, and the latest Edition of the Regulations of the Institution of Electrical Engineers definitely requires it where earthing resistances exceed 1 ohm.

A NEW FORM OF EARTH LEAKAGE PROTECTION

It is considered by electrical engineers with Indian experience that the method should be especially useful in that country owing to the problems associated with effective leakage protection. The purpose of this article is to give as concise a description as possible, without at the same time omitting details that make for a clear comprehension of the principles involved. Not that the apparatus or its technical application is in any way particularly involved, but as radical departures from hitherto standard practice are made, the conservative engineer has to be convinced almost against his will that the method can be effective.

The Home Office Report quoted above mentions apparatus connected between the neutral conductor and earth, and the sub-station switch, as it is called, will therefore be dealt with first. Apparatus for use on the consumer's premises will be described and illustrated later.

In the diagram, Figure 1, a sub-station switch is shewn arranged for the control of the outgoing low tension lines, in this case three-phase, although similar adaptions can be made for single-phase, two- or three-wire. The overload protective trips have been omitted for clarity, and it will be noted that the circuit can be opened by means of a trip coil T, this being connected between the neutral conductor and a supplementary earth connection at SE. The normal neutral earth is at E, and care has to be taken that the small supplementary earth is placed as far out of any probable sphere of influence of this main earth as possible. In the case of pole transformers the spacing should be as wide as conditions permit.

The trip coil T responds to a neutral potential depending upon the resistance of the supplementary earth SE; this may be of very simple construction, an ordinary driven spike or tube, and in practice its resistance ranges from one to seven or eight hundred ohms. Assuming a resistance of 500 ohms at this point, the trip will operate with a potential of about 40 volts upon the neutral line, the current required being in the region of the 30 milliamperes.

A potential of this magnitude will usually only appear by reason of fault—fallen phase line in contact with earth, and other causes,—and because of normal high resistance at the main earth E the lines cannot be isolated by means of the overload protective devices. The whole neutral point, including the sub-station gear, may therefore remain indefinitely at a dangerous potential to earth, whilst a comparatively high current flowing over main earth E will set up potential gradients, which have already proved fatal to cattle in this country and abroad.

It should be mentioned here that cattle and horses are susceptible to low leakage potentials that would usually be harmless to human beings, there being cases on record in which animals have been killed by pressures as low as 12 volts: 20-24 volts is considered the safe limit for animals in Germany, and investigation along similar lines is now proceeding in England.

Isolation under fault conditions may be readily effected with the apparatus shewn, however, and in practice the operation of the leakage trip is slightly delayed so that momentary potentials, representing no danger, do not unnecessarily operate the switch. It will be noted that the circuit through the trip coil is broken at the same time as the outgoing circuit; this is for the reason that should the high potential originate in the transformer or its switchgear, then no damage will accrue to the comparatively delicate winding of the trip coil because of current continuing to flow over it when the switch is open. No damage can occur in connection with the main earth E, but it will be noted that the neutral line is not disconnected at any time.

Apart from the effective protection afforded in cases of fault, it will be clear that considerable economy may be exercised in connection with the construction of the main earth E. It is no longer necessary to rely upon the low ohmic resistance of this earth, although it should be still constructed with a view to minimizing potential upon the neutral in the event of fault; the sub-station switch cannot do anything to prevent this potential, but only disconnect the lines in the event of it occurring. A high potential gradient extending from the main earth over the supplementary earth will delay isolation until there is still the requisite potential over the trip coil. It thus means that, although the supplementary earth may be of exceedingly cheap and simple construction, care must still be taken with the main earth, although full reliance is not now placed upon this main earth to cause isolation.

The potential at which the trip functions may be adjusted to suit local conditions; in Germany it is usually set at 42 volts—this being considered to be the limit to which human beings should be exposed in the case of A. C. supplies—but in Scotland a setting of 50 volts has, I believe, been considered suitable.

Figure 2 gives a view of the open type switch in which the overload trips are shown immediately below the contacts; the leakage trip is at the bottom, with the necessary adjusting mechanism. The neutral bar is on the right.

Figure 3 shews the same mechanism mounted in an iron case, with operating handle at the side. This is manufactured in England, and is now almost identical with the switch so widely used on the Continent. An outstanding difference is that whereas thermal overload trips are almost invariably used in Germany, in England the trips are magnetic.

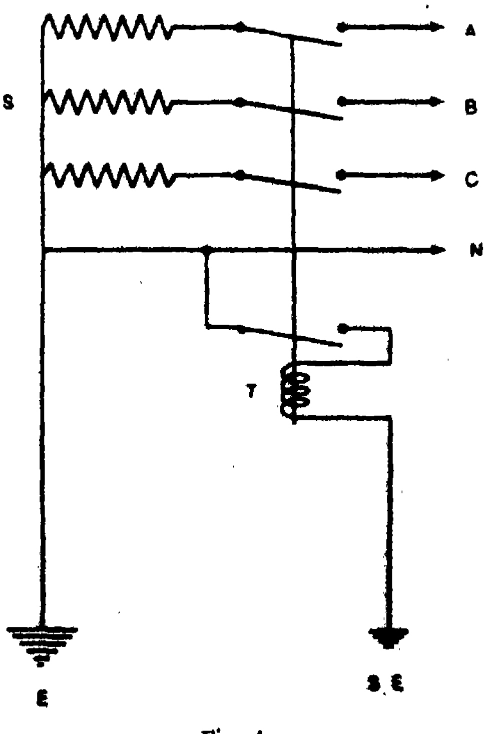

Fig. 1.

Sub-station switch. (Nalder Bros. & Thompson Ltd.)

In conclusion, it should be made clear that the device described cannot claim to prevent the appearance of a potential upon the neutral line, its sole function is to reduce dependence upon the main sub-station earth for isolation of the lines in the event of fault. This point will be clear to the practical engineer, but it is so often found that persons without experience in overhead line work persist in stating that potential may be actually *prevented* by the use of the sub-station switch.

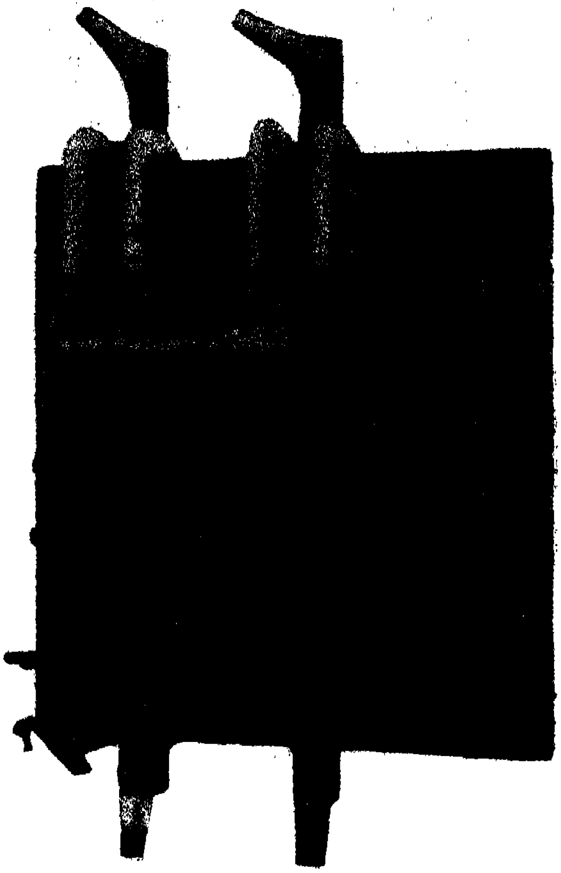

Fig. 2.

Open-type sub-station switch. (Nalder Bros. and Thompson Ltd.)

Arranged for single-phase three-wire distribution, with neutral earthed. Neutral bar on right.

The provision of a sound and reliable means of protection at this difficult point will, however, be quite sufficient recommendation of the method without exaggerated claims as to its more complete efficacy. Utilization over a long period on the Continent and for a lesser period in England and Scotland has now demonstrated the suitability of the method for universal adoption.

The British apparatus has been marketed as a complete range, as opposed to more or less experimental models, for such a short time that full distribution of the devices has not yet been fixed. I believe, however, that application to Messrs Siemens in any British Colony will ascertain prices and range.

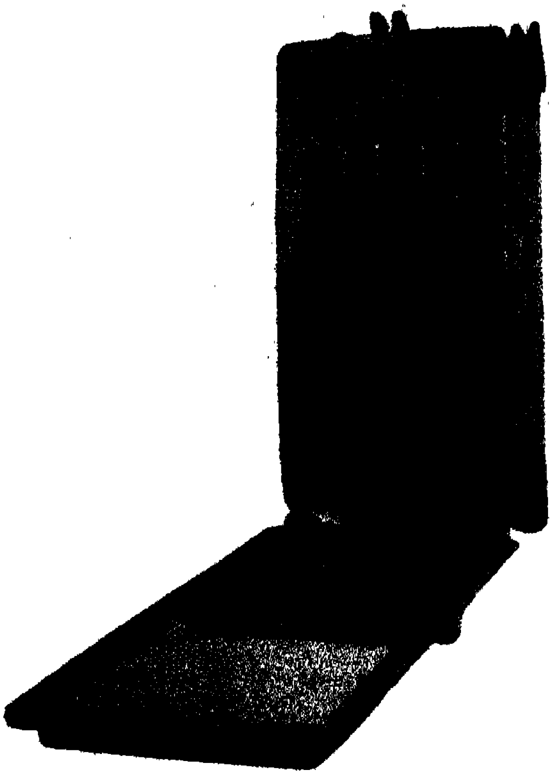

Fig. 3.

Appendix

An Investigation of Earthing Resistances, carried out by the National Physical Laboratory, Teddington, London, (P. J. Higgs, B. Sc.,) and incorporated in a paper read before the Institution of Electrical Engineers, London.

Reprinted in the Institution Journal, Nos. 402 and 406, the enclosed extracts being taken from my book *Artificial Earthing for Electrical Installations.*

EARTHING RESISTANCES

EARTHING RESISTANCES OF DRIVEN PIPES, MEASURED OVER A PERIOD OF ONE YEAR

Electrode No.	Length	External Diameter	Resistance in Ohms		
			Maximum	Minimum	Mean
	Feet	Inches			
6	6	1	43	36	39
7*	6	1	20	17	18
8†	6	1	21	17	18
9‡	6	1	—	—	330
10§	9	1	63	43	41
11	1	1	1,450	690	1,030
12	2	1	1,450	440	710
13	4	1	103	74	85
14	10	1	28	23	26
15	1	2	1,870	570	940
16	3	2	380	200	260
17	6	2	54	45	49
18	6	2	49	41	45
19	1	6	870	410	550
20	3	6	182	101	127
21	6	6	51	39	44
22	6	6	30	26	28

6 FEET × 1 INCH PIPES CONNECTED IN SERIES

	Distance apart Feet			
1 and 2	1	84	64	70
1 and 3	3	109	84	90
1 and 4	6	114	95	100
1 and 5	12	170	142	148

6 FEET × 1 INCH PIPES CONNECTED IN PARALLEL

1 and 2	1	37	31	34
1 and 3	3	37	29	33
1 and 4	6	35	29	32
1 and 5	12	44	34	39

The mean resistances of electrodes Nos. 1 to 5 were 56, 43, 49, 44 and 92 ohms respectively.

* Placed in coke bed about 6 feet long and 1 foot radius.
† Treated with 10 lb. salt dissolved in water.
‡ Bent so that 6 feet was buried 3 feet deep.
§ Tested once only, February, 1926.

(An Investigation of Earthing Resistances: National Physical Laboratory, Teddington, London).

ARTIFICIAL EARTHING FOR ELECTRICAL INSTALLATIONS

EARTHING RESISTANCES OF BURIED PLATES, MEASURED OVER A PERIOD OF ONE YEAR

Electrode No.	Size (Length × Breadth)	Depth in Ground	Resistance in Ohms		
			Maximum	Minimum	Mean
	Feet.	Feet.			
23	3×3	1	201	118	141
24	3×3	3	60	30	39
25	3×3	6	27	21	24
26*	3×3	6	30	20	24
30	6×3	6	18	14	16
31†	6×3	6	—	—	116
32*	6×3	6	14	11	13
33	6×3	1	77	48	60
34	6×3	3	28	19	23
35	6×3	8	15	13	14
36	6×6	3	27	16	20
37	6×6	6	18	11	15
38	9×3	6	14	11	12
39	9×9	6	10	8	9

6 FEET × 3 FEET PLATES BURIED 6 FEET DEEP, CONNECTED IN SERIES

	Distance between Centres in Feet.			
27 and 28	6	32	26	28
27 and 29	18	37	33	36
27 and 30	48	36	32	35

6 FEET × 3 FEET PLATES BURIED 6 FEET DEEP, CONNECTED IN PARALLEL

27 and 28	6	12	10	11
27 and 29	18	11	9	10
27 and 30	48	10	8	9

(Fractions of an ohm have been disregarded).

* Plate buried verticaly, mean depth 6 feet.

† Tested once only, February, 1926.

(*An Investigation of Earthing Resistances:* National Physical Laboratory, Teddington, London).

EARTHING RESISTANCES OF BURIED STRIPS, MEASURED OVER A PERIOD OF ONE YEAR

Electrode No.	Size (Width × Length)	Depth in Ground	Resistance in Ohms		
			Maximum	Minimum	Mean
	In. Ft.	Feet.			
40	2 × 10	1	131	82	98
41	2 × 10	3	55	23	37
42	2 × 10	6	26	20	24
43	1 × 10	1	254	115	155
44	4 × 10	1	98	50	64
45	8 × 10	1	87	38	50
50	2 × 25	1	52	18	27
51*	2 × 25	1	—	—	32
52†	2 × 25	1	16	11	13
53	2 × 25	3	37	18	25
54	2 × 25	6	14	12	13
55	6 × 25	1	29	19	22

2 INCHES × 25 FEET STRIPS BURIED 1 FOOT DEEP, CONNECTED IN SERIES

	Distance between Centres in Feet.			
46 and 47	1	56	23	34
46 and 48	6	80	35	48
46 and 49	16	87	38	51
46 and 50	36	94	39	53

2 INCHES × 25 FEET STRIPS BURIED 1 FOOT DEEP, CONNECTED IN PARALLEL

46 and 47	1	30	16	22
46 and 48	6	26	13	18
46 and 49	16	25	11	17
46 and 50	36	25	11	17

(Fractions of an ohm have been disregarded).

The copper strips in the above tests were $\frac{1}{16}$ in. thick.

* Tested once only, February, 1926.

† Placed in a coke bed.

(*An Investigation of Earthing Resistances*: National Physical Laboratory, Teddington, London).

Development of Education in India

George Anderson

Educational Commissioner with the Government of India.

THE progress of education in India is linked to, and impeded by, forces over which we have little or no control. There is, first, the obstacle of poverty of many kinds; there is the poverty of Government and of local bodies; there is also the grinding poverty of the masses who often have not the wherewithal to keep body and soul together. In this distressing predicament, parents can scarcely be blamed if they make use of the labour of their children instead of sending them to school. Next, there are ravages of disease, especially of malaria, which must often result in depleted class-rooms and in poor attendance. Another obstacle is the absence of good communications, which must result inevitably in diffusion of effort and in multiplying the number of schools beyond what would otherwise be required.

Yet another obstacle is the persistence of social customs, particularly as reflected in the attitude towards girls and women. Many are disappointed by the comparatively slow progress which has been made in the education of girls and contrast the rate of progress in India with that in certain other countries. In reply, I would ask what would be the effect if, in England, for example, the edict went forth that little girls should be taught in schools separate from their little brothers and that women should not teach in primary schools for boys; yet in India it is the ordinary practice for little girls to be taught in separate schools, and it is only of rare occurrence to find a woman teacher in a boys' primary school.

Please do not think that I am complaining or trying to make excuses; my main intention is to stress the vital importance of education in the life of this or any other country. Though education, by itself, cannot remove poverty, cannot improve communications, cannot abolish disease, cannot mollify social customs, it is yet the essential preliminary to all reform. Though we should therefore be humble in face of great responsibilities, we should not be unduly depressed because progress has not been as rapid as we should have wished.

There is much, indeed, that should cheer us in our labours. There is, first, the great quantitative advance which has been made in recent years. The fact that the enrolment in British India has advanced from 8 millions in 1917 to 13 millions in 1933 gives us at least a few crumbs of comfort. The indication is at least that the desire for education is growing rapidly.

In particular, there has recently been a great quantitative advance in the education of girls. Even more important, girls now tend to stay longer at school and thereby reap greater benefit by their schooling. The statistics are truly remarkable. The number of successful candidates in Matriculation rose from 1,002 in 1927 to 2,138 in 1932, and then swiftly to 2,770 in 1933 and to 3,325 in 1934. The Bengal figures are particularly exhilarating, the number rising from 157 in 1927 to 394 in 1931, and then rapidly to 609 in 1934. The degree figures are similarly pleasing, but I shall not overload my address with figures; those who wish to pursue the matter further can ascertain the figures from the reports.

In view of this advance, it is all the more distressing that provincial Governments, with the possible exception of Madras and the Punjab, have done but little to correct the disproportion in expenditure on the education of the sexes. It is difficult to resist the awkward impression that, during a time of financial stringency, the first item of expenditure to be thrown overboard is that on girls' education; yet this is the very time when, if it is to avoid the pitfalls which now beset the education of boys, the education of girls should be placed on a firm and stable foundation.

Another pleasing advance lies in the improved attitude towards the children of depressed classes. The most that was even thought of a few years ago was merely to institute a number of segregate schools, thus crystallizing the stigma of inferiority. The present and more salutary tendency is to rely less and less upon segregate schools, and more and more on ensuring that these children shall be admitted on equal terms with other children to the ordinary schools of the country. This healthy practice is steadily gaining ground, and reports from all provinces indicate that caste prejudice is rapidly disappearing.

I wish that I could give an equally satisfactory report on segregate schools intended for different sections of the community. In addition to the danger of unnecessary duplication and competition, segregate schools are not conducive to creating a happy and a united India. It is scarcely salutary that boys and girls, during the impressionable years of youth, should be educated in a narrow and restricted atmosphere; they should rather be mixing intimately with children of other communities and be trained in a spirit of tolerance and goodwill towards those of other creeds and beliefs.

Another sign of progress is the marked improvement in the playing of games and in providing facilities for healthy recreation and for physical training. Many schools are no longer the drab and dull places which they used to be; this exhibition alone is proof of this contention. I would say a word, in particular, on the subject of physical training. I have taken exception to the segregate school; I also take exception to the segregate teacher. The specialist in physical training (and he is abundantly needed) should be concerned with training colleges and with the work of inspection rather than with teaching in individual schools. If such specialists were available in the training institutions, it would be possible to ensure that all future teachers should be trained, in addition to their other teaching duties, to take part in physical training which would no longer be at the mercy of largely illiterate training instructors. Unless this policy is developed, I cannot see how physical training can be conducted in the primary schools of Bengal in that most of those are of the single teacher variety.

When, therefore, we review certain aspects of our educational system, there is good cause for satisfaction. When, however, we review the actual effects of our labours, when we realize (as we must) that the quantitative progress in primary education is by no means attended by a commensurate reduction of illiteracy, and that such increase in literacy as has been achieved is almost counterbalanced by the increase in population, when we realize (as again we must) that large and ever-increasing numbers of our pupils are unable to find suitable employment, when we review the enormous wastage which persists in all forms of education, our feelings of satisfaction are turned inevitably to those of grave disquietude.

The Hartog Committee were justified in pointing out that—

> "All sections of the community have little, if any, choice of the type of school for their children. The present type of high and English middle school has established itself so strongly that other forms of education are opposed and mistrusted, and there is a marked tendency to regard the passage from the lowest class of a primary school to the highest class of a high school as the normal procedure of every pupil".

In consequence of this aimless drift, large and increasing numbers of pupils prolong unduly a purely literary form of education with the result that not only do they congest the high school and university classes, but they themselves become unfitted for and indeed averse from, parctical occupations and training. Another unfortunate feature of our present system is that "the normal procedure" is interrupted every two years by a biennial examination. At each period of two years, a boy spends the period of six months of the first year in adapting himself to new conditions and often to new surroundings; he also spends the last six months of the second year in "cramming" for the next examination. There is thus little time or scope for continuity of study. Moreover, an examination should have a definite objective; it should test whether a pupil has completed successfully a definite stage of education; it should, therefore, come at the end of that stage. But our examinations appear to have no definite objective; they merely represent a succession of milestones along the dreary road towards a degree, which only a negligible proportion succeed in taking or even aspire to take.

We should therefore reconstruct our system of education in such a way that it shall be divided into a number of separate stages, each with a clearly defined objective and untramelled by university requirements. At the end of each stage, pupils should be diverted to suitable occupations or to vocational institutions. Such was the general plan of reconstruction which was recommended in 1934 by the Universities' Conference and which was endorsed a short while ago by the Central Advisory Board of Education. Let me try to review, very briefly, what should be these stages of education and what should be the objective of each.

Before doing so, I would ask you to note the word 'diverted.' The Board were careful to avoid the implication that they were proposing a restriction of educational facilities. Pupils should not be denied the benefits of education merely because their bent does not lie in the direction of literary studies. Such pupils should first receive a suitable measure of general education and then, on the basis of that foundation, they should be provided with ample facilities for practical training which would attune their bent to practical occupations and would not, as does the present literary form of education when unduly prolonged, render them averse from such occupations and training.

The Board first recommended that "the primary stage should provide at least a minimum of general education and training, which will ensure permanent literacy". It is extremely doubtful, however, whether even this very modest objective is being achieved, or whether India as a whole is making much leeway against the forces of illiteracy. Educational statistics provide the melancholy information that, in Bengal for example, only 15 per cent of the total enrolment of boys and only 2 per cent of the total enrolment of girls in the four primary classes reach Class IV (when literacy may be anticipated) within the prescribed period of time. Moreover, the conditions of village life being what they are, many even of the very limited number of pupils who attain literacy only too often relapse into illiteracy shortly after leaving school.

It has been represented that a rapid introduction of compulsion would be the panacea of all our ills and would speedily result in a literate India. I myself am a keen supporter of compulsion; the Punjab can at least claim that it has made vigorous efforts in that direction as, according to the latest statistics, as many as 3,073 school areas in the Punjab were under compulsion. But I am bound to admit that the effective results are by no means commensurate with the efforts which have been made. Unfortunately, compulsion cannot be introduced merely by an order or by a stroke of the pen: careful preparations are required.

In the first place, we have to take into account the gloomy subject of finance. I sometimes feel that a terrible amount of time and energy is wasted in working out detailed figures of expenditure which must inevitably be misleading and become quickly out of date. An approximate figure is easy to arrive at. Take the average cost of educating a pupil in a primary school and multiply by the number of additional pupils who would be educated as a result of compulsion and a definite figure will be reached. But there will be a world of difference in the ultimate and actual figure as a result of the degree of efficiency that will obtain. Suppose, by a stretch of imagination, that the teaching arrangements will be so efficient and attendance so regular that every pupil will complete successfully the primary stage within four years, the cost of compulsion would be comparatively small and would be amply justified. Supposing, on the other hand, that the teaching arrangements will be so ineffective and attendance so irregular that not a single pupil, even after a stay of six years at school, will complete the primary course, the cost would not only be infinitely greater but would not be justified. An essential condition to success is, therefore, that the schools in which compulsion is applied should be both efficient and economical. I am also doubtful of the morality of finding parents for the non-attendance of their children, unless and until we can assure them that their children would gain practical benefit by their schooling.

These considerations are appreciated in certain quarters; hence the proposal that compulsion should first be attempted in a few progressive districts. I do not myself agree with the partial introduction of compulsion in a number of wide areas, as such a practice would simply be a material interpretation of the Biblical text: "To him that hath shall be given, and from him that hath not shall be taken away even that which he seemeth to have". The amount of money available for primary education being limited, it would scarcely be equitable to devote the vast bulk of that amount to providing widespread facilities for every child in a given district, while children in other backward districts would inevitably become worse off even than before. Similarly, such a policy would accentuate still further the present disproportion in expenditure on education between the sexes. Are the girls to starve until their brothers have been amply fed?

On the other hand, I am strongly in favour of applying compulsion in every school area, in which the primary system is both economical and effective and in which public opinion is favourable. In other words, compulsion should be regarded as a reward for good work, good administration and general enthusiasm.

It is also for consideration whether it would not be advisable, at any rate in the initial stages, to concentrate on ensuring that pupils already at school shall remain at school rather than, as the Linlithgow Commission neatly put it, on "straining after the last truant". In any case, it is far more important in the initial stages to ensure that, year by year, those of the minimum age shall attend school regularly than to compel boys within a year or so of the maximum age to receive infructuous schooling and thus to embarrass the training of those who deserve good teaching.

Universal and compulsory education should not therefore remain a distant ideal; we should take immediate steps for preparing the way towards the achievement of that ideal. What should be those steps?

In the first place, we must decide what is the minimum time in which (granted good teaching and regular attendance) the average pupil can attain permanent literacy. The Sapru Committee has recently recommended a period of six years. We have been striving to reach the same period in the Punjab; and it is something at least that more than half of the primary pupils in that province are now enrolled in lower middle schools (with six classes in each), where the teaching should be far more effective than that given in the four-class primary schools. But we have to consider not only the large expenditure which would be involved by the introduction of a six-year primary stage, but also the dire necessity felt by parents in rural areas for the labour of their boys. I am therefore driven to the conclusion that, in present conditions, the primary stage should be one of five years. Be this as it may, I am confident that a lower primary school (with only three classes) is practically valueless either for the purpose of attaining literacy or for laying a firm foundation on which to build up an efficient and economical edifice of compulsion; yet the vast majority of primary schools in this Presidency are of this type and, what is even more unfortunate, they are almost invariably of the single-t[illegible]iety. The average enrolment of a primary school in Bengal is only 38, a figure lower than that in any other province except Bihar. I am therefore driven to the conclusion that the vast majority even of the comparatively small number of pupils who now reach Class IV within the normal period of time are enrolled in the primary departments of secondary schools and that the primary schools make almost a negligible contribution towards the reduction of illiteracy.

Having decided the duration of the course, the next step will be to provide the schools in which the course shall be *efficiently* taught; efficiency is essential as even a period of five years is all too short for the attainment of permanent literacy. The object in view should be that, in the interests of economy, every class of every primary school should include the full complement of pupils (say 25); and that, in the interests of efficiency, no teacher should teach more than one class at the same time.

Unfortunately, throughout India, there is much diffusion of effort in the primary system. A few years ago, the Director of Public Instruction, Bihar, observed that

> "There is a movement for substituting for the village school a variety of schools intended for the benefit of particular communities . . . . We are now reaching a stage when each village wants a primary school, a *maktab* and a *pathshala*. In addition, it is claimed that even at the lower primary stage separate schools are necessary for girls, and also in many places separate schools for children of the depressed classes. Thus, in poorest province of India, we are asked to provide five primary schools for each village."

We should therefore review at once distribution of primary schools. We must first eradicate all signs of ignoble competition. As already suggested, we should be scrupulously careful in giving the different classes fair play and in admitting their children *pari passu* with other children to the ordinary schools. We must next provide that the religious and cultural requirements of communities shall be duly observed with a view to providing in each school area a central school for all children within that area. Finally, though we should consider the urgent necessity of introducing a scheme of co-education at the primary stage, we should remember that such a system should apply not only to the pupils but also to the staff. Little girls should not be admitted to school with their little brothers merely by sufferance.

The next step will be to consider the curriculum of primary schools. In this respect there is danger of losing the right perspective; it is suggested that the curriculum should be overladen by a number of subjects, forgetful of the fact that the pupils are small children whose main business it will be to attain permanent literacy at the earliest possible moment. It is essential, no doubt, that pupils should be taught through the medium of what is familiar to them, that the reading books should be suitable, and so forth, but it would be of little value to recast the curricula and to re-write the text-books unless and until teachers who understand the new learning have become available. In this as in all other educational reform we should be careful to begin with the teacher and end with the text-book.

Our most important and difficult task, therefore, will be to find the teachers who, given reasonable emoluments and also reasonable conditions of work such as I have described, will be successful in imparting literacy to the pupils.

If, however, the teachers are to be successful, they should undoubtedly have received training; otherwise, they cannot be expected to be successful in the difficult task which lies before them. The figures unfortunately tell us the melancholy fact that the percentage of trained teachers in Bengal is only 28, a percentage lower than that in almost any province. Moreover, the number of primary teachers under training is so small that, at the present pace, it will be a long time before Bengal can reach a reasonable percentage of trained teachers in primary schools. I am tempted to suggest that the present system of maintaining a large number of minute training classes is neither efficient nor economical. A policy of consolidation, therefore, seems to be required.

It is also desirable that, in rural areas, primary teachers should be in sympathy with their environment, and should therefore have received their general training in vernacular middle schools. The recommendation of the Board that, at the secondary stage, "the courses in rural areas should be attuned to rural requirements" is therefore of great importance. The progress of the countryside is dependent very largely upon the guidance that should be given by an indigenous agency; it cannot be promoted effectively by means of sporadic and largely inexperienced efforts from outside. It is therefore unfortunate that, in the present educational system, boys and girls who might have provided that agency are often led away to the towns in order to receive a purely literary form of education, in consequence of which they not only congest still further high schools and colleges, but also become lost to the service of the countryside. It is therefore unfortunate that this type of school, on which the progressive development of the countryside largely depends, has fallen into decay in Bengal, especially as it is so very largely an agricultural province. A rural flavour or bias cannot be imparted merely by adding a book knowledge of agriculture to the curriculum of an otherwise urban school; what is needed is a vernacular middle school which is self-contained and whose objective is to train boys and girls in the service of the countryside. A country, which neglects and impoverishes its countryside, must inevitably lose sooner or later its reservoir of strength. It is for this reason that I rejoice that my own country is making belated but nonetheless laudable efforts to envigorate its countryside by means of a well-devised system of rural education.

I have suggested that there should be separate and self-contained stages of education, each with its own objective, and that at the end of each stage pupils should be diverted to practical occupations and training. The main point of diversion will undoubtedly be at the completion of the secondary stage. The crucial question, therefore, is when that stage should end. Statistics tell us that, in British India, 66 per cent of the boys in the higher classes of high schools cannot enter for, let alone pass, Matriculation until they are eighteen years of age or older. The indication is, therefore, that a very large number of pupils prolong unduly a purely literary form of education and that, by so doing, they become unsuited to, and indeed averse from, practical occupations and training. I therefore submit that the stiffening of Matriculation standards, by itself, would be wrong policy; it would not only be an undesirable form of restriction, but it would tempt pupils, with little or no literary bent, to prolong still further or even more infructuously their literary studies in high schools and to become even less inclined than they are now to practical occupations and training. The root of the trouble lies deeper than Matriculation; it is to be found in the schools themselves.

If vocational training is to be effective and successful, the main diversion from the literary form of education must take place before Matriculation. We must therefore select an age when, on the one hand, a pupil will have had time to acquire a sufficient measure of general education as a basis for his vocational training, and when, on the other hand, he will not have become so 'set' in the literary rut as to have become averse from practical occupations and training. At all costs, he must not wait too long.

The Board have advocated "a lower secondary stage, which will provide a self-contained course of general education and will constitute a suitable foundation either for higher education or for specialized practical courses." In view of the fact that, over and above this stage, there is to be a higher secondary stage, it is presumed that the proposed secondary stage will be of shorter duration than at present, and that its objective will be to provide a suitable measure of general training to pupils up to, approximately, fifteen years of age. This arrangement would seem to fulfil the two essential conditions; a suitable measure of general training and an age when the pupils would be more likely to take advantage of practical training.

What then of this practical or vocational training which will follow on after the completion of this shortened secondary course? Some urge that practical training should be provided as optional subjects along with the literary subjects. Such an arrangement, in my opinion, would be fatal to success. To be successful, vocational training requires expensive equipment and, above all, experience and practical teaching. Moreover, resourses should not be dissipated but should, as far as possible, be concentrated in institutions designed for the purpose. There is also a grave danger that a haphazard intermingling of vocational and literary study may defeat the very object in view; pupils might be tempted by the bait of somewhat superficial or intermittent vocational training to prolong unnecessarily their literary studies and thereby to become averse from practical occupations. I am therefore convinced that the new facilities for vocational training should be given as far as possible in separate vocational institutions.

We are told that all this will cost money and that India has not the wherewithal to meet the large expense that would be involved. I would reply that all education, in whatever form, costs money. The question at issue is whether we should continue the largely wasteful system of to-day or whether we should strive to spend at least a portion of the present expenditure on more productive and more practical forms of education. I am myself amazed that Governments and other authorities continue to subsidize a purely literary form of education for large numbers of pupils who are unlikely to reap benefit therefrom. To those with a statistical bent I would suggest that they should try and estimate the expenditure on those who are unduly prolonging their literary education. Count up the number of those pupils in high schools who cannot expect to enter for, let alone pass, the Matriculation until after reaching the age of sixteen or later, and then estimate the expense (capital, recurring and personal) which is incurred on their education. Count up, again, the number of students in colleges who fall by the wayside and never succeed, even after years of labour and of many unsuccessful attempts in taking a degree, and then estimate the cost of their successful efforts. I myself estimate the amount at Rs. 5 crores a year in British India. Whatever be the amount, it must be a very high figure. I do not suggest that the whole of this vast sum would, or could, be saved by a diversion of these pupils and students; my contention is that large sums of money are being squandered and that much of the money could be spent far more profitably by providing a more suitable form of practical training for these pupils.

I must now bring my remarks to a close, as I hope that there may yet be time for discussion. I realize that I have been able to give only a very brief sketch of the general scheme of school reconstruction which seems to me essential. I am not therefore in any way pessimistic. I am confident that, if only we educationists can carry on our work, each with a clearly defined and attainable objective, we shall at least not fail in carrying out our great responsibilities.*

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* Substance of a lecture delivered at the Bengal Education week, February 1936.

Annual Meeting of the British Association

Readers are reminded that the annual meeting of the British Association will be held this year in Blackpool, from September 9th to 16th, with Sir Josiah Stamp as president. At the inaugural general meeting Sir Josiah Stamp will deliver the presidential address, dealing with the impact of Science on Society. On the evening of September 10th a reception will be held by the Mayor and Mayoress of Blackpool in the Winter Gardens. The first evening discourse will be delivered by Mr. C. C. Paterson, who will speak on science and electric lighting, a subject of vital interest to Blackpool. The second evening discourse, by Captain F. Kingdon Ward, will deal with plant-hunting and exploration in Tibet. One aim of the Association, prescribed in its first Statute, is "to obtain more general attention for the objects of Science, and the removal of any disadvantages of a public kind which impede its progress." In order to help fulfil this aim, a series of papers, stressing the points of more immediate public welfare, have been grouped together in a series. Six of the presidential addresses are included in this series, as well as many of the other papers.

—*Discovery*, June 1936.

Sigmund Freud

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[We are glad to publish the paper on Freud by a leading psychoanalyst of India. It is not possible to do full justice to the versatile and prolific genius of Freud in a single paper and we are not without hopes that many things untouched in the present paper will be presented in future issues. Freud's contribution to the psychology of dreams, psychopathology of everyday life, wit, instinct, and allied topics can be treated only in a series of papers and not within the limit of space fixed for Freud in the present issue.

We subjoin a glossary of technical terms that are likely to present difficulties to lay readers.—*Editor*]

PROBABLY no man alive to-day, with the possible exception of Einstein, has influenced human thought in so many departments as the Moravian Jew, Sigmund Freud, who attained his 80th birthday on the 6th May, this year.

It is said that Lord Balfour, in the dedication of the new University at Jerusalem, referred to Freud as one of the representatives of intellectual Judaism. Others, especially on the Continent of Europe, have referred to his Semitism in less honourable terms, but the fact remains that Freud stands to-day as the innovator of a point of approach to the understanding of the human mind which has not only torn down the rigid line of demarcation between natural and mental sciences, but has profoundly influenced medicine, psychology, psychotherapy, anthropology, religion, literature, art, sociology, and criminology.

Freud's earlier researches were physiological rather than psychological. He was the first to introduce cocaine as an anaesthetic for operations on the eye. Like most medical men of his day, he believed that the problems of mental disorder were to be solved by exploring the brain and nervous system than by attempting a first-hand study of the mind itself. Like so many others, as he has himself told us, he began by tacitly assuming that what was not conscious must be purely physical. While still in his twenties, he went to Paris where he became a student at the Salpêtriére. As one among a crowd of foreigners sitting at the feet of the eminent French neurologist, Charcot, little attention was paid to him. Learning that Charcot was anxious to have his lectures translated into German, Freud offered to undertake the work. Charcot accepted the offer and Freud became henceforth a member of the circle of his personal acquaintances. While in Paris he studied the theories of Pierre Janet, another eminent neurologist. Charcot's investigations into hysteria made a deep impression on Freud, particularly an exclamation of Charcot: "In such cases sex is the most important thing—always, always." Freud felt that Charcot had proved the genuineness of hysterical phenomena and their conformity to laws, the frequent occurrence of hysteria in men and the production of hysterical paralyses and contractures by hypnotic suggestion. One remark, among many, that Charcot made in Freud's hearing left an indelible impression on his mind. One day, during a discussion of some objections to a particular theory, Charcot observed: "Ça n'empêche pas d'exister." Freud never forgot these words. After a visit to Berlin, Freud returned to Vienna. At once he was made aware of the truth embodied in Neitzsche's famous apothegm, "Mankind has a bad ear for new music." It would have been easy, particularly in the medical atmosphere in which he found himself, to accept the smug idea of medical nihilism in relation to the treatment of the neuroses, and to enjoy without a care his rapidly growing neurological practice. But his unrelenting criticism of the insufficiency of therapeutic ability and theoretical knowledge of the time led him to regard electrotherapy for the neuroses as futile. Similarly, the unreliableness of the occasional results obtained by hypnotic and suggestive influence induced Freud to give up these methods as well. His zealous drive for truth did not permit him to halt at mere criticism of the prevailing attitude. His inquisitive mind allowed him no rest until the questions he had raised had been solved. Without a doubt it was an accident that at that time the Viennese physician, Dr. Josef Breuer, had an intelligent female patient under hypnotic treatment, who observed in herself the favourable effect of talking about the content of her phantasies and called her physician's attention to her observation. She was, in short, the discoverer of what was later to be known as the 'cathartic method'. A mere coincidence brought Freud into personal contact with Breuer whereby he became acquainted with the important discovery that Breuer had made. He began to repeat Breuer's investigations with his own patients and after finding that Breuer's observations were invariably confirmed in every case of hysteria accessible to such treatment, and having accumulated a considerable amount of material, he proposed that Breuer and he should issue a joint publication. After expressing a good deal of opposition, Breuer eventually consented and in 1893 they published a preliminary paper, 'On the Psychical Mechanism of Hysterical Phenomena', and in 1895 the world received their book, *Studien über Hysterie*. This book did not seek to describe the nature of hysteria but merely to throw light on the etiology of its symptoms. In addition the book introduced an entirely new outlook on mental processes in general, namely, their dynamic nature, by supposing that a symptom arises through the damming-up of an affect. Therapeutic aim then became an attempt to direct the accumulated affect which maintained the symptom, along its normal path whereby it could obtain discharge (or **abreaction**). The practical results of this procedure were found to be excellent. These achievements were helped by Freud's application of the method of 'free association' so that it is no exaggeration to say that modern psychology was born at the moment when Freud's main idea was conceived. It was the discovery by Freud of the part played by the sexual instinct in the etiology of the neuroses that soon left him alone in the field, for up to that time only two men had been endowed with sufficient courage to publish their extensive studies of the instinct of sex—Krafft-Ebing and Havelock Ellis. Although Freud always employed the term 'sex' in a far broader sense than is customary, there is no doubt, his insistence on the importance of the sexual factor led many to affirm that he was obsessed with the notion and applied it at all costs. The result was that he was accused of delving into 'the dirty instincts', while others hurled such expressions as 'pansexuality' and 'dangerous psychic epidemic' at his teachings. These reactions of fury seem now to be nearing their end, for more and more voices, and among them distinguished ones, are inclined, at least partially, to confirm Freud's views. It is striking that such substantiations come not only from psychiatrists but from physicians, surgeons, gynoecologists, pediatricians, dermatologists, and so on. To-day many distinguished physicians are willing to rely upon analytic therapy in organic diseases. Psychoanalysis has taught, among other things, that it is not enough to treat a disease; we must go further and treat the diseased person. In 1908, at Nuremberg, the International Psychoanalytic Society was founded. Branches soon sprang up in cultural centres throughout the world. In Berlin, Vienna, Paris, London, Budapest, New York, and Calcutta as well as in other important cities, there are now clinics and educational institutions for the teaching and practice of Freudian psychotherapy. The official journals of the International Psychoanalytic Society are the *International Zeitschrift für Psychoanalyse*, *Imago*, and the *International Journal of Psychoanalysis*.

The separatist movements which are manifest in all great ideas, did not leave psychoanalysis untouched. During the years 1911-1913, two secessionist movements from psychoanalysis took place. These movements were led respectively by Alfred Adler and C. G. Jung. As Freud himself states, both movements seemed most threatening and quickly obtained a large following. Jung attempted to give the facts of analysis a fresh interpretation of an abstract, impersonal, and non-historical character, hoping thereby to escape the need for recognizing the importance of infantile sexuality and of the Oedipus complex as well as the necessity of the analysis of childhood. Adler departed still further from psychoanalysis. He repudiated the importance of sexuality, tracing back the formation both of character and of the neuroses solely to men's desire for power and to their need to compensate for their constitutional inferiority. Thus he threw all the psychological discoveries of psychoanalysis to the winds. In spite of the rather formidable challenge to psychoanalysis made by Adler and Jung, the effects of it wore off in the course of time so that after ten years these heresies have done little or nothing to undermine the foundations of psychoanalytic psychology.

As Sándor Ferenczi told us, Freud's concepts have wrought immense changes in psychiatry. No one is satisfied any longer with the traditional descriptive methods of labeling cases according to their symptomatic grouping. Freud's teaching has shewn that the symptoms of the insane cannot henceforth be regarded as a collection of abnormalities without meaning. He has shewn us that the psychopath speaks a language which is intelligible to the competent expert.

Although Schopenhauer and von Hartmann popularized the 'unconscious', and F. W. H. Myers had attributed genius, hypnotism, spiritualistic phenomena, and many peculiarities of our everyday experience, to what he called the 'sub-conscious mind', it was Freud who substituted closer observation for loose speculation, thereby showing what precisely was the nature, origin, and influence of these unconscious factors. Freud's work, as far as psychology is concerned, may be looked on as a reaction against the excessively intellectualistic attitude of continental psychologists of his day, an attitude that still dominates the psychology of the school room and the law court.

In England, psychologists under the lead of Ward, Stout, James, and McDougall, had already realized the supremacy of impulse, of purpose, of what Freud would call 'wishes'—in a word, of mental forces as distinct from mere ideas. Thus many of Freud's characteristic doctrines had been fore-shadowed in textbooks that emanated from Cambridge and Oxford. Perhaps on this account psychoanalysis obtained a far more ready acceptance among students of psychology in England than upon the Continent.

The services rendered by Freud to anthropology are best studied in his epoch-making book, *Totem and Taboo.* Here he shows that totemism has the same latent content as neurosis, or, in other words, that the social organization and religion of primitive mankind are based on the Oedipus complex. Where Freud has shewn the way, others were bound to follow so that we find many instances of the beliefs, customs, and traditions of primitive man now being subjected to scrutiny on psychoanalytical principles.

The first definite point of connection between psychoanalysis and the psychology of religion was a short contribution published by Freud nearly twenty-five years ago, in which he drew attention to the resemblances between religious rituals and the ceremonials of obsessional neurotics. A review of the subject has been made recently by Ernest Jones and published along with other essays on matters pertaining to psychoanalysis in book form entitled *Psycho-analysis To-day.* Jones cites some of the more important contributors to the study of religion and psychoanalysis, especially the work of Reik, Róheim, Levy, Lowenstein, and Kinkel. As Jones observes, the outstanding differences are plain enough, such as the social character of religion as contrasted with the individual character of the neurosis, the tremendous differences in the sense of value, and so on. Nevertheless, there are some striking resemblances, notably in the conscientious attitude towards both and the dread of conscience pangs if the acts are omitted. In Freud's opinion the obsessional neurosis represents an individual religiosity and religion a universal obsessional neurosis. He further concludes that both are dependent on renunciation in the field of primitive impulses, sexual or egotistic.

For information on the influence of psychoanalysis on literature, we may turn to a penetrating study of the topic made by Fritz Wittels. We cannot but agree with Wittels that a study of the art and literature of all times and of all nations evokes amazement by the discovery that we find therein all the complexes which psychoanalysis has brought to light recurring again and again.

It is not easy to predict whether this discovery will lead to a new golden age or to a decline in art. At any rate, psychoanalysis has shewn that art is deeply rooted in the unconscious depths of the artist and no one has demonstrated this better than Freud himself in his study of Leonardo da Vinci.

With regard to the value of psychoanalytical teaching to criminology, it should be fairly obvious that Freud's concept of the super-ego, ego, and id has done a good deal to elucidate many problems involved in the mind of the criminal, not to mention the help this concept has afforded for the understanding of the psychology of those who defend the law.

On this topic Paul Schilder has contributed some interesting reflections with special reference to the genesis of the feeling of guilt, a feeling that is slowly being recognized as a potent factor in the commission of crimes of all sorts. Schilder believes that the coercion or intimidation employed by parents, nurses, teachers, and so on, in training children to renounce their primitive tendencies, *i.e.* anal-erotism, pre-genital and genital activities, evoke fear and a sense of guilt that can only be relieved by punishment, for only by punishment can the child recover the love of his parents which, through misdemeanour, he has lost.

In the first few years of the life of a child, law and morals are identical. After the Oedipus complex and the super-ego are fully developed, Schilder maintains that the child wants to be punished not only that it may regain the love of the parents, but also in order to be loved again by its super-ego. What was primarily the relation between the parents and the child is now also the relation between the super-ego and the ego. Schilder maintains that we cannot understand this whole development unless we recognize that the parents have built up their own super-ego out of perpetual contact with society, and that the super-ego of the child is, therefore, also the reflection of the attitude of society. The demands of society, of the parents, and of the super-ego run parallel under ordinary conditions. The principles of law and ethics have characteristics in common in so far as they are both demands and orders. But the principle of law is made secure by an executive power, and the lawmaker not only gives orders to the individual but also to the executive organ of the law. Hence the feeling of guilt will be especially strong when we have acted against the law and its executive powers, but, at the same time, there is a feeling of guilt based purely on the fear of the super-ego. The law punishes only what has been accepted and made into action by the ego. The influence of the super-ego reaches further, for the super-ego is aware not only of our conscious tendencies but also of the unconscious ones. In these unconscious tendencies there will always be wild and criminal instincts to provoke a feeling of guilt which itself may not be conscious. Whenever there is an unconscious feeling of guilt, there will also be a desire for punishment, which makes the ego and the id lovable to the super-ego and the child in us lovable to the parents in us. When a child is brought up by parents who have no respect for the laws of society, when it is brought up in a criminal atmosphere, a super-ego will be developed with criminal tendencies. Of course, the super-ego developed in this way may be countered by parts of the super-ego of persons who comply with the demands of society. A child brought up under a double influence of this sort must suffer in the end with some weakness in its repression-mechanism. A weakness in the super-ego system will often lead to criminal action if the individual is self-confident enough. Whether or not a criminal impulse becomes a criminal action is therefore dependent on the relation between the criminal instincts and the ego. When the criminal instincts obtain the support of the ego, then we get, as a result, a criminal action. In view of the above considerations as well as in view of more that further research may bring to light, we are at liberty to ask with Schilder, are we justified in punishing a criminal?

Do we not satisfy, with the punishment, his masochistic tendencies? Do we not drive him deeper into his infantile attitude? Probably for some time to come lack of a sufficiency of accurate knowledge must make the questions unanswerable. Finally, psychoanalysis has a lesson for judges and law-makers, for it alone can teach them the deep similarity between themselves and the criminal and so prevent them from enacting their own criminal instincts, in the punishment of the criminal.

We may conclude this short sketch of Freud's contribution to human knowledge and its subsequent seeping into a multitude of human interests far removed from its original source, *i.e.* the treatment of neurosis, by citing the opinion of one of his most ruthless critics: "There can be little question that Freud has done more for the advancement of our understanding of human nature than any other man since Aristotle."

Glossary

AFFECT—Sum of excitation or emotion. In Freudian literature it generally stands for accentuated emotional reaction of which the cause lies in the unconscious; hence even when the ostensible reason of the emotional excitement disappears the emotion gets attached to some other object and thus perpetuates itself till the unconscious is laid bare.

EGO—The conscious logical self which is subject to the instinctive pressure of the ID and the moral control of the SUPER-EGO and is thus an intermediary between the two. It deals with the principle of reality and therefore recognises the external world of space and time. Even when asleep it maintains a censorship over its dreams.

FREE ASSOCIATION—The Freudian substitute for hypnotism as a means to the exploration of the unconscious. The subject reclines at ease and narrates the thoughts as they surge up in his mind, whether they are pleasurable or painful, gratifying or embarrassing, and thus unburdens himself of the load of repressed memories that cannot be otherwise tapped. Some of the repressed thoughts come up under certain conditions—these are the fore-conscious thoughts; others require a special technique and external aid in order to reach consciousness—these are the unconscious memories proper.

ID—The source of instictive energy for the individual and forming the congenital equipment of the individual. In its racial aspect it is almost synonymous with instinct and represents the tendencies with which the human race is endowed at birth. It is built up of the illogical, a-moral energies which seek the pleasure principle through the EGO and prompts its actions. In its personal aspect it represents the repressed ideas of the mind and it is the seat of libido or sex or love-energy, taking the word in its extended connotation. In both aspects it is the seat of mental dynamics and presses the EGO from the level of the conscious.

SUPER-EGO—It is partly a racial heritage and partly an outcrop of the EGO. It is not wholly accessible to the conscious self over which it maintains a kind of moral control. It is the earliest code of morality for the child and in relation to it the EGO develops a sense of guilt which it tries to expiate in a variety of ways. The EGO not only fights the ID but some times also the SUPER-EGO and represses thoughts impelled by both.

Anthropology and Growth

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THE recent researches of Dr. T. Wingate Todd and his school under the auspices of the Brush Foundation in the Western Reserve University, Cleaveland, Ohio, have led to many interesting results on the problem of human growth. The opening of such a line of work in anthropology is of utmost importance to every country and to all nations and it is worthwhile to summarize here the main contributions of the above foundation in this branch of science.

What was believed to be only the grim figure of destiny has now been the subject of the physical anthropologist. Ten years ago heredity was considered to be the main controlling factor of every human shape and kind. But the inherited trend is one thing and the degree of its expression is quite another. Before the studies of nutrition by the method of controlled experiments opened out the new possibilities of health, one would not believe to what an extent nature assists nurture. The possibilities of prenatal care have not yet been thoroughly explored but from the short period of fertility in the human female we can easily understand how cautious is nature. The diet and personal hygiene of the expectant mother and the claim of children are the vital problems of every society.

Dr. Boas set the first master furrow in anthropology when he showed that the differences in the headform between the parents and their foreign born children centre in the face and charactize in transverse dimensions. Bawkins has shown that undernourished or malnourished children suffer more in the growth of their transverse than of their longitudinal dimensions and these are seen both in the head and the body. The face is extraordinarily sensitive to the growth disturbances. Broadbent's studies have demonstrated a marked mininution of growth velocity in the dynamic centres of the face in malnourished infants. Hellman has shown that during the first five years of life, growth is active in the antero-posterior and transverse dimensions of the face, whereas the most vigorous vertical growth is observed after the fifth birthday. The defects of early malnutrition then should be sought for in the transverse and antero-posterior facial dimensions.

The heritable factors plainly guide the general course of growth but the occurrence of marginal examples which are often found in families representing two or three generations are the expressions of the intensified family characters. The two aspects of the hereditary problems in such marginal individuals consist firstly in the ease with which some bodily features can be changed and the stubborness of others in resisting interference, and secondly in the ever present mental defect. The first theme is well illustrated in hybridization. Penrose has recently shown that the intelligence quotient of the relatives of idiots is higher than that of the relatives of simpletons. The origin of simple-mindedness lies mainly in environmental conditions whereas idiocy lies in the primary structural defects of the brain. Both the above require two diverse lines of inquiry. The presence of simple-mindedness is relative of the conservation of healthy developmental growth in infancy and in prenatal period whereas idiocy is less insistent because of the family limitations. Cumulative anthropological observations show that hereditary patterns can be modified by conditions of life by which it is possible to improve the physical status of mankind.

Long ago Sir Arthur Keith subdivided growth into :—(1) functional, and (2) corporeal concomitants. All organs must grow to a certain size before it is functionally adequate.

The following are the growth observations on some of the organs :—

1. The vestibule definitely reaches the earliest functional maturity. It appears shortly before the appearance of those mass movements, which serve to keep the embryo balanced in amniotic fluid. The vestibule thus begins to grow upto the time of birth. There is no growth after birth.

2. The growth of the olfactory area of the nose is greatest before six months after birth. Later in infancy the respiratory part takes on its increased velocity but the olfactory area, functionally active at birth, displays a very small corporeal concomitant. In early childhood the middle of the nose bears the burden of respiratory growth. In later childhood the inferior part unfolds and growth of this area continues to adolescence approximately.

3. A tooth has no corporeal concomitant but is already full grown before the enamel organ first lays down the mineral in its cusps.

4. The eyeball reaches the adult size at about four years. The eyeball is essentially a part of the brain and the cerebrum in childhood shows that adult configuration of cerebral pattern is reached between the ages of four and six when the braincase is at least four-fifths the adult size.

5. Braincase growth is characteristic of infancy and early childhood, and with it the antero-posterior and transverse dimensions of the face, including the malar arches also increase. Vertical growth of the face is maximum in later childhood. Vertical growth of the jaws between the floor of the nose and the chin is vigorous at and after puberty.

6. The sexual differences in braincase and upper face are common in both the sexes. But the growth of the lower face is much greater in the male than in the female. Both in man and anthropoids the bodily growth in the female practically ceases at puberty, whereas in the male it continues for several years.

7. The final condition of the adult is therefore the results of the period of maximum growth for each organ or area of the body. Defective upper facial growth begins from childhood and inadequate jaw growth from adolescence.

8. Baldwin-Wood has shown that there is an yearly increase in stature of boys of about 50 mm. from six to thirteen and a half years. Between thirteen and a half to fifteen years the average gain is 100 mm. in one and a half years. The statistical variabilities studied by Dr. Lerro and Mrs. Wood under long term observations show that the so-called variation sets in earlier and finishes later than the above limits. The adolescent increased velocity of growth in stature is the result not so much of the increase in the growth of leg as of the enhanced trunk growth. The relatively long legs and short trunk of some people who are not tall is due to the defect of trunk growth rather than to increase in leg length. Thus maximum velocity in leg length is a function of childhood whereas maximum velocity in trunk length is a characteristic of adolescence. This difference is clearly marked in achondroplastic dwarfs, where the velocity of leg growth is approximately half the normal and the growth of trunk is less handicapped.

9. The growth in stature is accompanied by pelvic breadth and this takes place in three different stages :—(i) Necks of femora; (ii) Iliac blades; (iii) Sacrum. The appearance of menstruation, however, in most but not all growing girls gives a clue to the relation between dimensional increase and progressive maturation at one level of developmental growth. The rapid growth of stature is revealed more before the menses; very little is observed afterwards. The roentgenograms of the growing ends of the bones show the replacement of a lethargy of progress in maturation before by a period of greatly invigorated maturation afterwards. This fact is known in all growing girls, although it has not yet been stated specifically in quantitative terms.

It was the pioneer contribution of Pryor to apply the X-ray for the study of growth. This X-ray study has been also applied on the nutritional deviations by the workers of the Brush Foundation. The practicable methods of measuring maturation is found among physical features. This led Crampton and Furfy to investigate the external expression of progressive maturity in the growth of public hair. The presence of sperms in the morning urine of adolescent boys and the onset of menses in girls were taken up by Baldwin and others. Pryor began to investigate the date of bone formation in the cartilages of wrist and ankle, and the end pieces of limb bones. Scammon took up the growth curve of the body in the four systems; bone, brawn, breath, and blood being responsible for the skeletal, muscular, respiratory, and circulatory systems respectively. The psychological responses claim equal attention with the physical reactions. The former is influenced by training, experience, and physical maturity. It can not parallel physical progress after six years or less in children, as it is more dependent upon adjustment and acceptance of the environment than body function.

The application of X-ray in the study of nutritional deviations by Miss Kuenzel and Dr. Todd consist in the roentgenograms of the stomachs of medical students. Each student was given a measured quantity of milk, whose stomach was first ascertained by roentgenography to be empty. They found "the milk enter the stomach but within five minutes the volume of fluid in the organ has been doubled owing to the secretion of the gastric juice." They found the mingled milk and gastric juice entering the bowels in small quantities within two minutes and if the milk taken is less than three ounces the stomach is practically empty within twenty minutes. The sense of fullness comes not from the milk drunk but from the secretion of the gastric juice induced by the milk. Buttermilk induces a secretion three or four times the volume of milk.

The presence of lime in the bones of the expectant mothers was also the subject of inquiry by the above workers. The modern X-ray equipment enables to ascertain the fluctuation of mineral in the bones. The requirements of a body, whether adult or child, is one gram of calcium per day, approximately the amount contained in one quart of milk. The foetus at the sixth month contains about five grams of calcium but at birth the baby's body contains 30 gms of this mineral. Thus an expectant mother needs 7 quarts of milk a week for herself and 2 quarts for her baby. If she does not get this amount she withdraws from her accumulated stores. This fluctuation of lime can be observed roentgenographically. After the baby is born the mother's bones continue to show the depletion of lime reserve for the lime is going to the milk. The depletion of lime reserve is also seen in the mother, who is not nursing the baby, as although she is not producing the end product, the milk, the constituents of milk are eliminated from the system.

Roentgenography has also helped in observing the greater incidence of tuberculosis among adolescent girls in America, as they are afraid of milk lest their contours be not of Hollywood standards. Previously nutritional deviations were only thought of in terms of weight and although weight is inseparable from the theme of nutrition—particularly in the case of the adults—roentgenography is of very material assistance in the determination of adequate nutrition in children.

Thus physical anthropology can be transformed from a static study of structural form into a kinetic study of structural progress. The structural progress has its utility in the application to eugenics as it gives a detailed insight into the characteristics of family lines and the development of marginal individuals. The anthropologists' researches throw light on the vagaries of emotion, on problems of social adjustment, on failure in promotions and a host of other problems of the children between the ages of four and six.

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Plant Sociology and its Economic Importance

F. R **Bharucha**

THE last world war, while it destroyed thousands of precious lives and put out of use for ever acres of invaluable lands both agricultural and sylvicultural, it did one great thing and that was to give a stimulus to research in every branch of science. Amongst the sciences which assumed greater importance during the war were the chemical and agricultural. While the necessity of encouraging the growth of the former arose merely for the speedy annihilation of the enemy, the greater growth of the latter arose from the dire necessity of supplying one's own men with sufficient food. As the war dragged on, greater and greater shortage of food was felt. This forced every nation to concentrate its efforts on producing more of the food stuff. For example, lands that were formerly unproductive were brought into use by scientific means; those that produced one blade of grass formerly were made to yield two. In short, plants began to be studied more intensely in relation to their environment. In other words, the world war gave stimulus to the young science of plant ecology.

This impetus that the study of plant ecology received during the war did not end with it. On the contrary the interest that it created grew with surprising rapidity which developed within a comparatively short time into the modern science called *Plant Sociology* or *Phytosociology*.

The term *Phytosociology*, now urbanized into Plant Sociology, was coined by Krylov and Paczoski as early as 1896. The term itself (not the point of view, the material and the scientific structures signified by these) has been objected to on linguistic and etymological grounds. In spite of this, it has readily become internationally accepted because it is at once expressive and directly understandable.

Now plant sociology is the science of grouping plants into associations, communities or societies and finding out the laws that govern these societies.

Though the Third International Botanical Congress of 1910 defined an association as a plant community of definite floristic composition the wide difference of opinion evident at the Fifth International Botanical Congress at Cambridge, 1930, shows how the problems of individualizing, marking out, and delimiting any plant association from the complexities of the composite mosaic of vegetation are questions of deeper analysis and thought.

A given plant association may occur in many localities but it was found that it exists usually in only a *typical, well-defined* and *ecologically charasteristic habitat.* This led on to the long continued efforts towards delimiting and sharply defining each characteristic habitat, which may enable us to arrive at a classification of plant associations. This object was not realized due to various causes.

The more sharply it was sought to delimit the meaning of the habitat, the more complicated and involved it became. Due to various and variable external factors and their possible manifold combinations, a clear and unequivocal definition of habitats appeared quite unattainable. On account of this difficulty, it became more and more necessary, in investigating the plant communities, to deal directly with the vegetation itself. And we have now realized that the starting point of the study of vegetation should have been the natural grouping of plants. Therefore, temporarily ignoring the habitat, the floristic individuality of the plant communities is sought to be recognized and defined.

The exact floristic analysis of the individual communities of vegetation leads to the synthesis of plant communitities. This analysis and synthesis afford the basis for conclusions regarding the combinations of species, the numerical relations of the individual species, and the significance of each species in the origin, development, maintenance, and decline of plant communities and especially of the fundamental units of vegetation, viz., the *associations*. Thus the primary task of the plant sociologist is to define and delimit the plant associations of a region.

Any attempt at the valuation of a type in terms of actual combinations of species in nature would, therefore, result in a chaotic splitting up of vegetation as would be presented to us in every quarter of a square meter of a meadow community. Our task would thus become impossible for the purposes of scientific generalization. What is necessary, therefore, is to institute comparisons between the various bits of vegetation, combine these bits of vegetation with similar floristic combinations into abstract types which may be called *associations*. Separate pieces may be called *individuals* or *examples* of the association or, more simply, *stands*.

It will be very evident that the greater the number of *stands* are investigated, the more adequate and reliable will be the resulting picture of the *association*. And from such (rather more than less perfect) agreement in the floristic composition of these stands, the uniformity of the association and the range of its variation could be derived in terms of greater and greater accuracy. In this way an association more and more indicates the characteristics common to the *individuals* that make it, and is like all scientific categories a group concept meant to deepen the meaning of inter-relations between individuals, and therefore, not merely of itself but of the whole phenomenon under investigation. In this particular case, let us remind ourselves, *vegetation* forms the phenomenon under investigation.

For the actual delimitation of a plant association in the field the method adopted is of noting down the names of all the individual species found on a homogeneous piece of ground of a definite size. In actual practice a cord square (1 sq. m. or more according to the type of association) is laid on the ground and then the names of all the species within the area are noted with numerical values attached to each species. To give an exact picture of a piece of vegetation, mere mention of a list of species found in a particular area does not suffice. For example, a plot may have three mango trees and a thousand shoots of grass but the three trees will far outdo the thousand shoots of grass in controlling the situation by their dense shade. Hence, formerly, botanists vaguely used the terms *common, rare, abundant,* or *scarce*. But it was felt as time passed that a more exact and accurate system was needed to indicate the amount of *covering* or *dominance* of a plant species. Hence, to-day various scales are in use, and we give below the one framed by the Zürish-Montpellier School of Ecologists, which is the one getting most recognition in different countries:—

*1—if the covering is very feeble.
2—if the species covers from 1/20 to 1/4 of the area.
3—„ „ „ „ „ 1/4 to 1/2 „ „ „
4—„ „ „ „ „ 1/2 to 3/4 „ „ „
5—„ „ „ „ more than 3/4 „ „ „
+—if only one specimen is found of a species.

†Table

LIFE FORMS.	Inclination & Exposition	2-3° N.	2° SE.	0°
	Altitude in m. s. l.	305	175	20
	Degree of soil cover by vegetation	80%	70%	85%
	Area of the plot studied			
	Characteristic species			
Ch.	Phlomis lychnitis	1.1	3.2	2.2
Th.	Trigonella gladiata	—	—	2.1
G.	Iris chamaeiris	1.2	—	2.2
Th.	Vicia amphicarpa	—	+ .1	+
Th.	Echinaria capitata	—	1 . 1	—
Th.	Scandix australis	—	+	+
Th.	Medicago coronata	—	—	—
G.	Narcissus dubius	—	—	—
G.	Allium chamaemoly	—	—	—

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* For details cf. *Vocabulary of Plant Sociology* by J. Braun-Blanquet and J. Pavillard. Trans. by F. R. Bharucha, Cambridge, 1930.

† This is a very small part of Table 9 from *Etude Ecologique et Phytosociologique de l' association a Brachypodium ramosum et Phlomis lychnitis des garigues languedociennes* par F. R. Bharucha, Beihefte Zum Bot. Centralblatt, Bd. L., 1933.

PLANT SOCIOLOGY AND ITS ECONOMIC IMPORTANCE

But the indication of the dominance of a species does not suffice, for a plant may be dominant and yet may not be able to influence much the other plants in its vicinity. Such a case occurs when a dominant plant is not evenly distributed. Hence the concept of *sociability* or *aggressiveness* of a species was introduced. It is also indicated, as *dominance*, by a scale from 1 to 5. The accompanying specimen table shows the method of indicating the *dominance* and *sociability* of a species.

To give a still clearer picture of a piece of vegetation further details are necessary. Hence many new concepts have been introduced into the study of plant sociology, viz.,* of *Fidelity, Constancy, Constructive* and *Destructive species, Characteristic species* of an association, etc. As it is not possible to treat in this paper all the above mentioned concepts a few of the most important ones only will be explained here (for details cf. *Plant Sociology* by J. Braun-Blanquet, 1932).

There are certain species which seem to be exclusively confined to an association. These are called the *characteristic species* of that particular association. This concept is not universally recognized. These species may be compared to fossils of a geological period.

Again, there are species which claim special attention on account of their *constructive* and *destructive* habits. *The dune plant *Ammophila arenaria* is a classic example of the *constructive type*. This grass after germinating in the moving sand spreads itself rapidly by its rhizomes and fixes the moving sand dunes. It thus creates a suitable habitat for the other plants to live in and for the subsequent establishment of an association. Under the shade of *Ammophila* other shrubs germinate, especially the species, *Crucianella angustifolia,* which finally by its growth overpowers and destroys the former. Crucianella is furthermore an example of a *destructive type*.

Just as the dominance and sociability of a species of an association are indicated by figures, so also the *constructive* and *destructive characters* of a species are indicated by particuler signs: Thus a table derived in the above way reflects a true picture of that piece of vegetation.

Finally, a few words may be said regarding the utility and practical importance of the study of *Plant Sociology*. It has two principal aims : (1) *Static,* to show the value of an association as an indicator of certain ecological characters; (2) *Dynamic,* attained when it would be possible to foresee the changes of vegetation brought about either by a natural agency or some artificial intervention of men or animals.

(1) **Static view-point of plant associations** : Botanists and naturalists are already familiar with the idea that certain plants indicate certain soil or climatic conditions. For example, the presence of the *Chesnut* tree indicates a soil poor in $CaCO_3$ and the presence of *Schoenus nigricans* indicates a soil rich in $CaCO_3$. Or again, certain plants indicate the thermic conditions, viz., the *Ilex aquifolium* is not to be found in countries where the maximum winter temperature remains for more than twenty days below zero. Such examples of plants as indicators can be multiplied indefinitely. But experience has shown that *plant associations* can be employed as indicators of ecological conditions with much greater advantage than only *individual plants* as cited above. This is particularly so in a new country where problems of afforestation or of agriculture are to be solved. One or two examples chosen at random will suffice to prove the importance of the *association* as an *indicator* of ecological conditions. In the south of France there are two important plant associations : (*a*) Association of *Lithospermum fruticosum* found on *eocene, impermeable, clayish* soil; (*b*) Association of *Brachypodium ramosum* and *Phlomis lychnitis* found on jurassic, very permeable, calcareous rock. *By experiment it was found that water filters 500 times quicker through the second soil than through the first per unit

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* *L'importance pratique de la Sociologie vegetale* par J. Braun-Blanquet. S. I. G. M. A. No. 4.

* *L'eau et l'air du sol dans l'association a Deschampsia media et Brunella hyssopifolia* par J. Braun-Blanquet et B. Pawlowski S. I. G. M. A. No. 10.

volume of soil. These two associations, with quite the opposite soil conditions, help us in the policy of afforestation of the region. Observations have proved that Pines, ***Pinus halepensis***, succeed only on the impermeable moist soil of the *Lithospermum fruticosum* association, whereas the Green Oaks, ***Quercus ilex***, regenerate easily on the second type of soil. Yet this lack of necessary knowledge on the part of the foresters led to disastrous results in the reforestation of the permeable soil with Pines.

In the Cévennes similar failures have been registered during experiments in afforestation. Foresters there have tried their best to plant successively on the top of the mountains Pines and Larix, but have totally failed, and the cause of the failure though apparent was not perceived by them. The association that is to be found on the top of these mountains indicates conditions hostile to the development of trees. Plants found in this association, such as *Vaccinium ultiginosum*, *Juncus trifidus*, indicate very rigorous conditions arising from effect of dry winds. The presence of the latter plant is a sure sign of conditions totally hostile to the development and growth of trees.

(2) **Dynamic or genetic view-point of plant associations**:

A plant association does not remain stable. It changes in the course of time till it attains a stage which is in perfect equilibrium with the soil and climatic conditions. This final stage is called the *Climatic Climax*. Vegetation in the course of its evolution goes through many stages and the process is called *succession*. Thus the Green Oak forests which once covered the southern coast of France represented the *Climatic Climax* stage of the region. To-day the bare heath lands (garigues) have replaced these forests. The question as to what tree should be employed to reforest this region has baffled many foresters, and as above stated, millions of francs have been wasted in experiments in planting the Pine (***Pinus halepensis***) instead of the Green Oak (***Quercus ilex***) which was and is to-day the climatic climax of the region (*l.c.* Bharucha).

Lastly the example of the Swiss National Park may be given here to illustrate the importance of the dynamic study of vegetation. Since 1916 close observations by means of permanent quadrats and otherwise have been kept on the forests of *Pinus montana*. It is found that on the floor of these forests the seedlings of *Pinus cembra* flourish best. Under one old *Pinus montana* no less than 32 seedlings of the *Pinus cembra* were found flourishing, ranging in height from 10 cm. to 5 m. These observations prove conclusively that the *Climax community* of the region is not the present *Pinus montana* forest but rather the *Pinus cembra-Larix* forest.

Thus vegetation studied, both from the static and dynamic points of view, will help to clear many complex economic problems of agriculture and sylviculture. The study of plant sociology helps especially when a totally new area of land is to be brought under cultivation.

The Sixth International Congress of Physical Medicine

B. B. Bhowmik

It is well known to every medical man that the modern physics is finding more and more application for the cure of human diseases. Everybody is aware of the use of Roentgen rays and radium in the diagnosis of internal disorder and in the treatment of malignant diseases like cancer. As early as 1905 an International Congress of Workers in Physical Medicine was organized and held in Liège. Several such congresses were successively held in Rome, Paris, and Berlin, and then it remained in abeyance for a long time during and after the War. In recent years physics is finding increasingly greater use by the medical men. In fact the application is increasing at such a rate that the physical medicine has developed into several different branches. A central authority to co-ordinate all branches of physical medicine was felt needed. As a result the Sixth International Congress of Physical Medicine was organized and held in London from May 12th to 16th under the chairmanship of Sir R. S. Woods, M.D., F.R.C.P.

The Congress was attended by delegates from twenty different European countries, United States of America, and some South American States.

The Congress arranged a very interesting programme under the following sections:—

1. Physical Education.
2. Kinesitherapy—Science of the movement in its connection with physical education, hygiene, and therapy.
3. Hydrotherapy and Climatotherapy—treatment by means of hot bath, brine bath, mud bath, etc. and by means of artificial atmospheric conditions.
4. Electrotherapy—treatment by means of Galvanic, Faradic, high frequency (Diathermy) currents, short waves, and high frequency inductive currents.
5. Actinotherapy—treatment by means of light, ultra-violet and infra-red rays.
6. Radiotherapy—treatment by means of X-rays, radium rays, and cathode rays.

In each section a large number of papers were read by competent experts and discussed by the members present. Besides, an exhibition was arranged showing the latest types of apparatus used in physical medicine.

The first day of the Congress was devoted to the addresses and papers of general character. In the opening ceremony, an address by the Hon. President, Lord Horder, who was unfortunately attending another medical meeting in America, was read by the Hon. Secretary. In this address importance and claims of systematic physical education was urged. He strongly advocated certain criteria which must be applied to the rapidly extending practice of physiotherapy. The first criterion was that the various methods and forms of technique employed in physical medicine should be brought and kept under scientific control. This could only be achieved if a close relation was maintained between the physiotherapist and the physicist. A second criterion for success was a constant realization by the physiotherapist that his approach must be a clinical one. A third criterion was a strict conformity with accepted pathology. The fourth criterion was a liberal association of all workers in this particular field. Free discussion, criticism, and publication were essential to success.

Professor W. T. Astbury, then, gave an address on "New Ideas from X-Ray Analysis on the Molicular Structure and Properties of the Proteins." He said that study by X-Ray diffraction methods was now possible of the actual form and stereochemical changes of many important protein structures and in particular those fibrous proteins which play such a predominant role in the frame-work of living things. A great contribution of physics to medicine is that they had been able in the laboratory to transform crystalline proteins to fibrous proteins.

In the afternoon Lord Dawson of Penn gave an address on "Physical Education". He gave a brief history of physical education from its early days. He said that physical education belonged to school hours and games belonged to the hours of recreation. If education were needed to get the best out of one's mind, it was unreasonable to expect that it was not equally needed to make the best of one's body. He then stressed on the needs of training colleges and trained teachers so that physical education might avoid failure by being in the hands of the untrained.

The remaining three days were mainly devoted to scientific papers in different sections. In the section of Physical Education many demonstrations were given by groups of pupils of different ages illustrative of progressive training with explanatory interpolation. In the section of Kinesitherapy, Hydrotherapy, and Climatotherapy, apart from scientific papers, visits were arranged to differents hospitals specializing in these branches where actual applications could be seen.

In the section of Electrotherapy, which was most largely attended, many interesting papers were read on the application of short waves for internal treatment of various diseases. The principle of this method is that extremely short electromagnetic waves of lengths below 12 cm. are generated by means of Valve Oscillator, and when a part of the human body is subjected to these waves it is heated. By proper manipulation of the electrode and the part of the body, the heat can be localised. A very good discription of the technique of the apparatus and a report on its use is given by Dr. Erwin Schliephake (Germany) in his *Short Wave Therapy* translated by Dr. R. King Brown and published by the Actinic Press, London. A similar book has also been written by Dr. E. Weissenberg, Vienna, Austria. Dr. Schliephake and Dr. Weissenberg, and several experts from France and America read papers and joined the discussion.

The new school of workers in this line say that the short waves, apart from being an agent for heating through and through the diseased portion of the body, definitely have some specific effects. They say that they have cured certain diseases by applying these short waves with very little energy of about one watt, which cannot produce any heat to raise the temperature of the diseased part. But the old school still maintains that it is the generation of internal heat that plays the part of curing the disease.

Some very interesting papers were read by American experts on fever therapy. Many diseases can be automatically cured if the temperature of the whole body can be raised to a certain high temperature. Illustrations with lantern slides were shown how by means of short waves and closed chambers the temperature of the whole body can be raised and disease cured.

Exhibition Section

The outstanding feature in the exhibition hall was short-wave apparatus of various capacities 1,000 watts to 300 watts shown by various firms of manufacturers. These machines can be plugged to any ordinary house electric supply. A different form of this apparatus of a portable form was placed on the market by an American firm. They make use of the principle of induction furnace. A high-frequency current generated from a three electrode valve is passed through a pan cake coil. When this coil is placed over any part of the human body it generates heat by eddy currents.

Dr. A. van Wijk of Phillip's Glow Lamp Works, Eindoven, Holland, exhibited high pressure quartz mercury lamp. The pressure of the mercury vapour is so great that the spectrum no longer consists of discrete lines, but is continuous. His object is to place on the market a source of light which will be continuous like sunlight and can be used in place of the sun. The power consumption was extremely small, considering the high luminosity. Many new kinds of shock-proof portable X-ray sets were demonstrated. These can be carried by one man in a leather bag to any patient's house and plugged to 220 volts mains. Thus the patient can get the benefits of X-rays without going to the hospital.

Demonstration was given on Electroline Refrigerator which was originally invented in Sweden —(*see* Saha and Srivastava—*Treatise on Heat*, page 281). But this is placed on the market by a British firm. It has no movable parts, but can be operated by a gas burner or a spirit lamp, and the working expenses compare very favourably with the refrigerator driven by electricity. Considering the fact that the price of electricity is 5 or 6 times as compared with European countries, this refrigerator should have large sale in India.

Sinusoidal sets were shown which work from the A.C. mains, copper oxide (Metal) rectifiers being made use of for rectification.

The above short account of the International Congress of Physical Medicine shows how backward we are in India, in the application of these new methods in physics for curative purposes. Very few medical colleges in India have got a competent physicist who can advise them in the use of the apparatus at their disposal. Average medical men generally go by the rule of thumb. The few colleges which have got radium store it in a form so that it is available only to those who can come to the hospital. There is no arrangement for the preparation of radon tubes and lending them to outside practitioners. In most of the hospitals in Europe where X-ray therapy is administered, competent physicists are employed for periodic inspection of X-ray plants, for regulating and calibrating the X-ray output and ascertaining their penetrating power. It is desirable that every medical college should have competent and trained physicists, and universities should have chairs of bio-physics as insisted by Dr. Frank Howitt (London) while presiding at the general meeting of all sections and opening a discussion on "Teaching and Organization of Physical Medicine in Universities and Hospitals." He said : "Whereas treatment might give relief beyond the scope of other sciences, their incorrect selection or improper application might bring damages and disaster beyond repair. Physiotherapy must be brought into line with all other specialities as an integral part of clinical medicine. As a corollary to its compulsory teaching in the hospital curriculum, they should press for the inclusion of questions on physical medicine in both "pass" and higher degrees. There was a great need for the institution of a chair of bio-physics in the universities. This would facilitate research, advice, and technical assistance, and there would be an authoritative body available to investigate the merits of new apparatus and discoveries. Moreover, discreditable claims could be crushed at their inception."

People and Castes of Bengal

Bhupendra Nath Dutta

OWING to the lack of proper perspective of the Indian history it is the general impression that Bengal had been an unknown country in the earliest period of so-called Aryan civilization. But a proper knowledge of the Sanskrit literature tells us that Bengal is an old country and was not unknown to the Vedic people. The *Rig Veda Samhita* speaks of the eastern sea (X. 136-5). The name of Pundra is mentioned in the *Aitereya-Brahmana* (VII. 6) and of Vanga in the *Aitereya Airanyaka* (II. 1.1) of the Vedas. From these, it is evident that Bengal was known to the Vedic people, and her people were contemporaneous with the same.

It is in post-Vedic period that Bengal began to be clearly noticed in the Sanskrit literature. We do not know the era when the founder of *Sankhya* school of philosophy, the sage Kapila, founded his *asrama* in Bengal and, according to mythology, destroyed 60,000 sons of Sagara. The date must have been anterior to the post-Vedic period. But after the end of the Vedic period, we find it is mentioned in the Jaina annals that Mahabir Vardhamana preached his religion in Rarh *i. e.* West-Bengal. Still later in the time of Alexander's invasion, the Greek writers mention the name of the *Gangaridae,*[1] who dwelt on the banks of the lower course of the Ganges. Afterwards, Bengal became a part of the Maurya Empire, as attested by the recent discovery of a copper-plate at Paharpur in Bogra. The same plate[2] also speaks of the Sam-Vangias who were Vratya-Kshatriyas like the Licchabbis and, like them, lived under an oligarchical form of republic.

All these testify that people of Bengal, along with the other *prachya* (eastern) peoples, did not take kindly to Vedic sacerdotalism. This is attested by the penances prescribed in the post-Vedic age (circa 400-500 B. C.) by Baudhayana (I-i. 32,33) for the Vedic Brahmans who visited Pundra, Vanga, and other countries. Thus, it is clear that Bengal along with other parts of Eastern India was the seat of heterodoxy. On this account, orthodox Brahmanism, *i. e. Varnasrama-polity*, never took roots in Bengal in ancient times; hence we find Jainism, Buddhism with its various ramifications[1], besides other heterodox sects, flourishing in Bengal in pre-Mohamedan days.

As regards the racial affinity of the people of Bengal with the Vedic people of the Punjab and the upper Gangetic valley, we have no date in our hands to say anything about it. But we know that as, according to philologists, the Bengalee language is ardhamagadhi, and its civilization had been Indo-Aryan, Bengal has been from time immemorial a part of the Indo-Aryan cultural circle. Streams of immigrants[2] from the Punjab and the upper Gangetic valley have been coming to the lower Gangetic land bringing their language and institutions along with them and settling in the province. As a result, Bengal, like other portions of Northern India, is an integral part of Aryavarta. It is included in Manu's definition of Aryavarta, as he said. "The country situated in the east by the sea, in the west by the sea, in the north by the Himalayas and in the south by the Vindyas, is called *Aryavarta* by the learned" (2. 22). Again, the Brahman minister of the Varman Rajas of East Bengal, Bhavadeva Bhatta, gloried in the 10th century A. D. that his native village at Rarh was a part of Aryavarta[1].

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[1] McCrindle—***Ancient India***

[2] *Vide* K. P. Jayaswal's Presidential speech at Indian Oriental Congress held in Baroda.

[1] N. N. Vasu—***The Modern Buddhism and its followers in Orissa***—Introduction by H. P. Sastri.

[2] Rajanikanta Chakravarty—*Gaurer Itihasa* pt. I, Ch. V. quotes from the Sanskrit text of Dhruvananda Misra that the Sur dynasty of Bengal came from Darada (modern Daradistan) country. This dynasty ruled in West Bengal in the 10th century A. D. It was a Brahmanical dynasty, though Manu has cited the Dards as Vratyas who not seeing the Brahmans have become degraded to Sudrahood (10. 44), yet the Brahmans accepted this family as an orthodox Kshatriya one. And perhaps the myth about Adisur who is alleged to have imported the Vedic Brahmans in Bengal has centered around this family. The Varman dynasty ruling in East Bengal about the same time hailed from the West Punjab (*vide* R. D. Banerjee: *Banglar Itihasa*, Pt. I.) The Chandra dynasty also ruling in East Bengal came from Behar (*vide* N. G. Mazumdar—"*Inscriptions of Bengal*, Vol. III.) The Senas came from Karnataka (South India), *vide*—N. G. Mazumdar, *Ibid*, Vol. III. Many castes trace their origin from the North and West India, as well as some castes from Orissa. Again many families trace their descent from South India.

To know further about the racial affinities of the inhabitants of Bengal, we will have to take the help of physical anthropology. Somatological test is the final test of racial identity, hence we will have to take the help of anthropometry in this matter. As the people of Bengal speak an Aryan language, we will have to enquire first about the original carriers of this language in India. The accredited homeland of the original Aryan or Indo-European-speaking people of India is the land of five rivers and the valley of the Cabul river. Here, the recent archaeological excavations have discovered skulls of diverse origins. Sir John Marshall, writing about the authors of the "Mohenjo-daro and Indus civilization", says, "As far back as history can be traced the population of Sind and the Punjab had been a blend of many diverse elements and there is no reason for assuming that it was other than heterogeneous in the earlier age with which we are now concerned".[2] Thus the craniological examinations discover various biotypes to be existing in the land of the five rivers from time immemorial. But this does not solve the question about the origin of the carriers of the Indo-European language to India. Here, we must be careful about the identity of the language and the race of men who speak it. Since the days of the philologist, Frederick Müller[3] every attempt to identify race with language has proved a failure. Hence any attempt to identify those Vedic tribes who spoke a branch of the satem group of Indo-European language, with a particular race or biotype, would be to hit beyond the mark. The attempt of the Pan-Germanists to identify Indo-European-speaking people with a particular biotype of North Europe has led to national chauvinism which has been derided as "Germanism".[1] This attempt has been renamed now-a-days as "Nordicism". But the dispassionate scholars know that such like hypotheses, however clothed in scientific garb, are to be found in their last analyses to have political bases. These are bound up with national or sectarian chauvinism. In Europe, "Aryan Controversy" long ago has entered its political phase. Truly an English writer, V. Gordon Childe, says, "The apotheosis of the Nordics had been linked with policies of imperialism and world domination : the word "Aryan" has become the watchword of dangerous factions and especially of the more brutal and blatant forms of anti-semitism. Indeed, the neglect and discredit into which the study of Indo-European philology has taken in England are very largely attributable to a legitimate reaction against the extravagancies of Houston S. Chamberlain and his ilk, and the gravest objection to the word Aryan is its association with pogroms".*

Hence, to wean our mind away from this national chauvinism of some people of North-Europe who maintain that the tall, long-skulled, narrow-nosed, blue-eyed, and light-haired racial type of men came all the way from Scandinavia or North Germany or the Baltic coast to India and founded the Indo-Aryan civilization, and in their migration to the east changed their centum dialect to the Sanskrit branch of the satem-group of the Indo-European languages, we must know the other hypotheses and facts connected with the problem. The student of this question knows that the majority of the opinions regarding this problem are in favour of the oriental origin of the Indo-European-speaking peoples. On this account, Dr. Koppers has said, "Ziehen wir die Schluss bilanz, so Zeigt sich, dass die von den Ethnologen in der indogermanenfrage vertretene ostthese nach wie vor unerschüttert darsteht". (In drawing the concluding balance, it shows that the eastern thesis advanced by the ethnologists regarding the Indo-German question lies unshaken as before).*

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[1] *Vide* N. G. Mazumdar—Zimmer—*Alt Indisches Leben. Ibid* p.36-Bhubanessur inscription of Bhabadeva Bhatta (verse 3)—"the only one tnat is famous in this world and has adorned the country of Aryavarta is the village of Siddhala, the formost of all, and the ornament of the fortune-goddess of Radha"

[2] Sir J. Marshall—*Mohenjo-daro and Indus Valley Civilization*, Vol. I p. 109.

[3] F. Müller—*Grundriss der sprachwissenschaft.*

[1] G. Sergi—*The Mediterranean Race*, p.8. He says "I mean by Germanism the theory which attempts to prove that the Germans are the primitive Aryans".

*V. Gordon Childe—*The Aryans*, p.164. Childe complains that L. Stoddard in *Racial Realities in Europe* has imported this false principle in American politics (*vide* footnote p. 164). But what about India from the standpoint of this Aryanism ?

But a new hypothetic race from the steppes of South-West Siberia and Central Asia has been created by some of the post-War anthropologists, and it has been named as the "proto-Nordic[1]" or the "Caspian" race[2]. Of course this race is supposed to be blonde and has got the characteristics of the Nordics, while the supposed Caspian race contains the long-skulled elements in them. It seems, in order to get over the difficulties beset with the hypothesis of the Nordic origin of the Indo-Europeans, the new hypothesis of the "Proto-nordics" from Asia has been set up. And the cradle of the blonde racial element which has so long been supposed by the protagonists of "Germanism" to have been North-European only has now been shifted to South-West Siberia and Central Asia by the representatives of "proto-Nordicism". Jochelson's[3] discovery of blue- and grey-eyed, light-haired persons in West Siberia, and the previous discoveries of the same characteristics with the Central Asiatic tribes[4]—the Galtschas, the Tajiks, etc.—by Ujfalvy, Aurel Stein, Schwarz, etc., have given the anthropometric basis of the same hypothesis. But these Central Asiatic tribes are not dominantly long-skulled[5]. The broad-skulled, narrow-nosed tribes speaking satem dialects (Iranian) of the Indo-European language are said to have also the above-mentioned characteristics combined with a regular facial feature. Hence, the Indo-European Aryan problem has got another orientation in physical anthropology.

The Aryan controversy is mentioned here, because it has become the fashion with some to identify the Vedic tribes with the Nordics of North Europe and to evaluate the people of Bengal from that standpoint. But it has been found out that in pre-neolithic time two types of skulls, dolichocephalic (long skull) and brachycephalic (broad skull), have been prevalent in North Europe[1] and in palaeolithic deposit at Solutre a brachycephalic skull has been found out. Hence the theory of the longskulled, narrow-nosed (dolichocephal-leptorrhin) biotype as the only original race of North Europe since the Palaeolithic race falls to the ground. Then another argument advanced by the upholders of Nordicism—blondness of eye and hair-colour—also falls to the ground since the discovery of Jochelson of this trait with some of the Tartar tribes of South-West Siberia. Hence, any trace of blue and grey eyes and blonde hair with the Indians or the Hindus in particular is not to be accounted for from the influence of the Nordic strain from North Europe, but it may be traced from the elements nearer home. *i. e.* from Central Asia. Patanjali's description of the physical characteristics of a Brahman in the *Mahabhashya* of Panini (II 26) as *Gaura succhachara pingala kapilakesa* does not warrant us in taking him as of viking type. According to Halaudha's *Abhidhana Ratnamala* (a Sanskrit vocabulary translated by The. Aufrect, 1861), *pingala* is brown or tawny, and *kapila* is tawny; and *Gaura* is generally fair. According to the Indian standard *Gaura* is brunette and not florid-white. Taking the meaning together, we see that Patanjali's Brahman is a fair-skinned, brown-eyed, and tawny-haired man of pure habits. Thus, there is nothing of North-European Teutonic traits in him. Rather, he can be taken as a fair-skinned man of India that is to be met with even to-day. On the contrary Sabara in his *Bhashya* on Jaimini I. 3. 3 quotes a Vedic text which speaks of the black hair of the Brahmans.[2] The *Atharva-Veda* also speaks of black hair of the head (B.K. VI 13F) Again, Manu's prohibition of marrying a girl with *pingala* *i. e.* brown or tawny hair (3. 5) may not give us somatologic proof of Nordic strain. People of India have aversion to 'cat's eye' and there may be similar aversion to tawny hair due to its extraordinary, hence uncouth, character. On the other hand, the Baka Rakshasa, in *Mahabharata* (Adiparva-168Ch) is described as having eyes, hair, and beard of red-colour. Also, the *Ramayana* (Sundarakanda-17ch) describes the Rakshasis as having *pingala* eyes. Further, the *Bhattikavya* speaks of the Rakshasas having *pingala* (tawny or brown) hair and *pingala* eyes (II. 30). Would these descriptions signify the demonic Rakshasas to have been of Nordic affinities? On the other hand, *Garga-samhita* speaks of *Kalajavana* having red beard (*Golakkhanda*-18).

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* D. Koppers—Die Indo-Germanenfrage in Lichte der historischen völkerkunde. in *Anthropos* Band XXX, 1935.

[1] E. von Eickstedt—*Rassenkunde und Rassengeschichte der Menschkeit*, p. 2631; Haddon, *Races of Man.*

[2] R. B. Dixon—*The Racial History of Man*

[3] Jochelson—Quoted by Eickstedt and V. Guiffrida—Ruggeri.

[4] Ujfalvy—*Le Kohistan, Le Ferghannah & Kouldja*; Aurel Stein—data worked out by Joyce—*Jour. Anth. Inst.* B.16; K. Schwarz—*Turkestan*, p.23.

[5] Ripley—*Races of Enrope.*

[1] Richard Hausmann—*ubersicht uber die archeo. Fosschung in den. ostprovinzen in letzten yahrzent.* Riga 1908; and Hausmann und weinberg. *Sitz der Ester* 1903. 71. p. 7; Keith. *Antiquity of Man.* Vol 1. p 110. 1935.

[2] This *sloka* has also been quoted in *Baudhayanasruti* V. 2-3-5.

Thus it is clear that the enemies of the Indo-Aryans are also described as having light-coloured eyes and hair. Hence to suppose Nordic strain only with the Brahmans will be misinterpretation of history.[1] Brown-eyed and tawny-haired men we have got in India in galore. Further, the Vedic description of the *Arya* does not also give us the impression of his being a Nordic. Rather we have seen beforehand that the Vedas speak of their having black hair. Indeed, the Vedic saying that the gods (*devas*) are white and the *Dasyus* are black (Rg. 2. 20. 8) does not lead us far into the knowledge of the somatology of the Vedic tribes. It seems the meaning of this white colour is clear in the white *Yajur Veda* where in Saturudriya Litany the god Rudra is called as "golden-armed" (16. 1f) and god Sabita as "golden-handed" (1. 20, 34, 25). Again, the saying that "Indra by killing the *Dasyus* has specially protected the Arya-colour" (3. 38. 9) does not give us further clue to the much-vexed problem. Regarding the colours of four different classes of the society which are known as the *varnas*, it may be said that these are the metaphorical representation of the different professions in which the peoples were engaged. There cannot be any anthropological meaning attached to these descriptions as the four *varnas* (colours) certainly were not the four racial types of men described by Blumenbach. Here we must remember that the Rigsthule or the Heimedall *Saga*[1] of the ancient Teutons speak of the creation of three classes of people with different kinds of physical traits and colours by the god Rig. But no one has yet made any racial discoveries in them. If the latter be an allegory the former must be likewise. Further, the other Indo-European peoples like the Persians,[2] the Ionian Greeks[3] had also traditions of the division of the society into four tribes or classes. According to Vincent Smith, "*Varna*, once a common name for all classes, perhaps taken from the colour of the garments that differed with different classes came to mean caste in post-Vedic literature". Hence *varna* is not to be taken in the colloquial sense that it means colour of the skin, but as the Sanskrit literature testifies, it means characteristics. The *Bhagabat Gita* says "I have created four *varnas* according to quality and work" (4.13). "The *Mahabharata* likewise says that the *varnas* originated from work" (Santiparva 184)

Examining the modern peoples of the homelands of the ancient Vedic tribes Dr. von Eickstedt says, "The Aryans can scarcely have been darker than the Pathans measured (No. 3). The *Dasyus* cannot have been fairer than our present plain-dwellers".[4] And those who have personal knowledge of the Pustu-speaking, the Swati-speaking peoples of the frontier, know it well that brown-skinned and dark-brown-skinned peoples are to be met with amongst them in preponderant numbers. Further, Dr. B. S. Guha in his Ethnographical Report of the Census of 1931 speaks of "a distinctly dark element present in varying degrees" in the N. W. Frontier Province;[5] thus a dark racial element is to be met with in the homeland of the ancient Vedic people.

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1. We must be careful about Patanjali's descriptio- of the Brahmans. Perhaps he like Panini hails from Gandhara as he was an admirer of *Atharva-Veda*. He had a vague idea of the East and the North and a good idea of Saurastra and Kamboja—*vide Mahabhasya* (Benares Ed. p.20. Introduction 1-1) The identification of Patanjali's birth-place gonarda with Gonda of U. P. is doubted by Cunningham.

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1. Bluntschli—*Allgemeine staatslehre* pp. 129-130, I. A. Macculloech—*The Mythology of all races*. Eddic. p. 153.

2. Senart—*Caste in India*.

3. Sir W. M. Ramsay—*Asiatic Elements in Greek civilization* pp. 243-244.

4. E. von Eickstedt A Comparative Anthropometry of 144 Punjabees in *Man in India* Vol. III. 1923.

5. V. A. Smith *Ancient and Hindu India*. pt. I p. 36.

Notes and News

British Recognition of Indian Medical Degrees

The General Medical Council of Great Britain has accorded recognition to degrees given by the Universities of Bombay, Lucknow, Madras, and Patna, and not by all the Medical Faculties in India. The courses, examinations and degrees of the other universities that have medical faculties—viz., Calcutta, Punjab, Andhra and Rangoon—are still being considered by the Indian Medical Council whose inspector's reports will go to the British G. M. C. in due course.

Recognition of the Bombay, Lucknow and Madras degrees was withdrawn in February 1930, and has now been renewed with retrospective effect back to that date. Graduates who have taken their degrees there during the past six years will accordingly be admitted to practice in Britain, and will be allowed to sit for such higher British degrees as the F. R. C. S. without having to take the qualifying examinations. Patna's qualifications on the other hand have not previously been registrable in Great Britain and are therefore recognized as from May 11 last year when its M.B. B.S. degree was admitted to the first schedule of the Indian Medical Council Act.

It is hoped that some at least of the four remaining Faculties will now be recognised on terms as favourable as those conceded to the universities mentioned.

Calcutta Electric Rates

In the course of a note submitted to the Calcutta Corporation regarding the recent reduction of rates announced by the Calcutta Electric Supply Corporation, Dr. B. M. Dey, Chief Engineer of the Calcutta Corporation remarked :

"The plea of paucity of resources and inability of reduction of management and working costs, is not a new one. The same plea was put forward in 1930 when the case for cheaper electricity was mooted by me. The Supply Company at the time declared that their charges, namely, the net domestic rate of 3 annas per unit, were irreducible. Better counsel, however, prevailed and the English Board of the Company thought fit to voluntarily reduce the domestic rate to 1½ annas in two instalments. Now, almost simultaneously with the publication of the Inquiry Committee's report they have again voluntarily reduced the rate to 2¼ annas."

Referring to the arguments put forward by the Committee on his analysis of unit costs placed before them in support of the tariff proposed by the Calcutta Corporation, Dr. Dey pointed out that "a comparison with other electrical undertakings—doing a fraction of the business of the Calcutta Electric Supply Company—should, surely be a good guide in this respect."

"If the Supply Company," the note added, "do not see their way to bring down the rates further, it should be a matter for consideration for the Calcutta Corporation to exercise their option of taking over the supply of electricity to the citizens, on the expiry of the present license of the Supply Company. In the meantime, Government may be requested to give effect to the Committee's recommendation without any delay and call on the Supply Company to comply with the same."

The Report of the Rates Inquiry Committee along with the Chief Engineer's note is likely to come up for consideration before the Public Utilities and Markets Committee of the Corporation early next week.

German Scholarships for Indians

The India Institute of the Deutsche Akademie announces the award of 17 (seventeen) new scholarships for the academic year 1936-37 to the following Indian graduate students who are to carry on higher studies in various German Universities :—

1. Mary K. Das and Taraknath Das Scholarship : Miss Usha Haldar, M.B.B.S., Lady Hardinge *Medical College, Delhi.*

2. Robert Koch Scholarship : Mr. G. S. Guha, M.B., Surgeon in Shillong (Assam).

3. Ashu Tosh Mukherjee Scholarship : Mr. Suprasanna Sen Gupta, M.Sc., Observer, Indian Meteorological Department, Rangoon.

4. Sir Ramkrishna Gopal Bhandarkar Scholar-

ship: Mr. Aryendra Sharma. m.a., University of Allahabad.

5. Friedrich Rueckert Scholarship: (This scholarship was primarily destined for studies in German language and literature; on account of the excellent application submitted for studies in indology the scholarship was this year awarded for this branch of studies). Mr. R. N. Dandekar, m.a., Professor of Sanskrit, Fergusson College, Poona.

6. Justus von Liebig Scholarship: Mr. N. K. Seshadriengar, m.sc., Bangalore.

7. Carl Duisberg Scholarship: Mr. Basudeb Banerjee, b.sc., University of Calcutta.

8. Heinrich Hertz Scholarship: Mr. N. K. Saha, m.sc., Allahabad.

9. J. C. Bose Scholarship: Dr. A. K. Dutt, d.sc., Bose Research Institute, Calcutta.

10. Oskar von Miller Scholarship: Mr. N. Anjaneyulu, b.sc., Assistant Professor in Metallurgy Benares Hindu University.

11. Werner von Siemens Scholarship: Mr. Nand Lall Gulali, b.sc., Government Technical School, Lahore.

12. Heinrich Schliemann Scholarship: Mr. T. Balakrishnan Nayar, m.a., Lecturer in History and Archaeology, Annamalai University.

13. Wilhelms Ellenberger Scholarship: Mr. P. C. Nag, g.b.v.c., Veterinary Assistant Surgeon, Sylhet.

14. Albrecht von Thaer Scholarship: Dr. Panchanan Maheshwari, d.sc., Lecturer in Botany, Agra College, Agra.

15. Adolf Ledebur Scholarship: Mr. B. S. Sanjeeva Reddi.

16. Jakob Grimm Scholarship: (This scholarship was primarily intended for studies in German language and literature; on account of the excellent application submitted for studies in fine arts, the scholarship was this year awarded for this branch of studies). Miss Sheila Bonnerjee, Artist Calcutta.

17. An additional scholarship has been awarded to Mr. Basheshar Nath Tandon, m.a., Professor of Commerce, Meerut.

The scholarship holders are due to reach Munich on September 1.

New Exhibits at Science Museum, South Kensington

A special exhibit of the R. M. S. *Queen Mary* is being held at the Science Museum.

The central feature of this exhibit is a magnificent 22 ft. model of the R. M. S. *Queen Mary*. A collection of photographs are also being exhibited, showing the vessel at various stages of her construction, the launching by Her Majesty Queen Mary on the 26th September 1934, and on her recent journey from Clydebank to the King George V dock at Southampton.

A model of the first Cunard liner, the paddle-steamer *Britannia* of 1840 which carried 115 passengers, constructed to the same scale as the model of R. M. S. *Queen Mary*, is shown alongside by way of contrast; while a representative series of other notable Cunard liners, down to the "Mauretania" which was broken up last year, serves as an historical background.

The R. M. S. *Queen Mary has a gross tonnage* of 80,733, and her four screw-propellers are driven by geared turbines of 200,000 horsepower. During her recent trials, she is said to have attained a speed of nearly 33 knots. With an overall length of 1,018 ft. and a breadth of 118 ft. the dimensions of R. M. S. *Queen Mary* are nearly the same as those of the contemporary French liner "Normandie," photographs of which are exhibited in the Steamship Gallery on the second floor of the Museum.

A special exhibit, which has been formed by the Royal Aeronautical Society to mark the 70th anniversary of its foundation, was recently inaugurated in the Science Museum. The exhibit comprised aeronautical objects d'art, aeronautical trophies, medals, engravings, stamps and rare or unique articles connected with ballooning and aviation, many of which have been lent by private collectors and have not previously been exhibited.

The effect of the invention of the balloon on contemporary decorative art will be seen in examples of vanity boxes, fans, handkerchiefs, buttons, snuff boxes, pottery and other articles. Famous balloon ascents will be illustrated by contemporary prints and relevant MSS., including the first air passport issued in 1836. The first aeroplane project will be shown in a rare coloured specification drawing of Henson's "Aerial Carriage," and the advent of the successful aeroplane by a bust of Wilbur Wright which fittingly supplements the original weight machine already in the Museum.

Mysore Government and Sapru Report

The Government of Mysore have made a detailed examination of the Report of the Sapru Unemployment Committee with reference to conditions in Mysore and have issued a statement showing what is actually being done by way of unemployed relief in the light of the suggestions made by the different departments of the State.

Some of the main points referred to by the Government are as follows :—

The expenditure on public works is being maintained at a fairly high level. In recent years, there has been a large development of irrigation in the Irwin Canal area. The department is encouraging engineering graduates who come forward to take up contracts Employment is also being found for them in connection with village improvement works.

No difficulty has been experienced in placing mechanical and electrical engineering graduates in Government and private institutions for receiving practical training. Arrangements have also been made with the Kolar Gold Fields for training and recruiting local people.

The development of rural electrification is continuously taking place. Action is being taken to increase the power generator so as to meet the anticipated additional demand and the sources of new power are being investigated.

THE INDUSTRIES

The manufacture of steel and rolled sections has just been started and the manufacture of pharmaceuticals established on a permanent basis.

The lac industry is being developed and an organisation created for industrial research. Factories for the manufacture of electrical materials, cement, paper and spun silk are being established either by Government or with Government aid. Facilities have been afforded to a private company for the manufacture of accumulators and schemes for the starting of new industries are under the active consideration of the Board of Industries which consists of officials and non-officials interested in industries and commerce.

With the additional allotments made by Government, arrangements are being made for the increased distribution of disease-free seed and cross-breed layings to the sericulturists and other measures are also being taken to help the industry through the present crisis.

The rates charged for power have been recently reduced in the interests of small industries.

NEED FOR STUDY OF DETAILS

The following recommendations deserve to be examined in detail by the Government and the officers concerned :

(*a*) Maintenance of unemployment statistics by Government, University and the Education Department.

(*b*) Grant of subsidies to medical men to settle in rural areas.

(*c*) The compulsory retirement of all Government employees who have attained 55 years. This is the rule and is invariably followed except in the case of ministerial officers.

(*d*) The development of subsidiary agricultural industries such as fruit growing, dairy farming market gardening, poultry farming, etc.

(*e*) To bring up-to-date Mr. Sambasiva Aiyar's Industrial Survey of Mysore.

(*f*) Establishing contacts between the Science Departments of the Mysore University and the Institute of Science and industrialists and businessmen.

Unemployment Relief by U. P. Govt.

The United Provinces Unemployment Committee's report was discussed by the Legislative Council on March 2 and 3, 1936. Government then undertook that if the Legislature voted additional taxation, they would earmark three lakhs of rupees per annum for the purposes mentioned in the Report and an additional one lakh for schemes of expansion or improvement in various transferred departments which would also have, as their result, reduction in unemployment among educated young men. The taxation measures (Stamps and Court-fees) were adopted by the Council in March. Accordingly, the following schemes of recurring expenditure have been accepted.

(*i*) Practical training for industries in a special colony at Cawnpore under almost commercial conditions, Rs. 25,000.

(*ii*) State-aid in the establishment and running of (*a*) an industrial credit company, Rs. 1,50,000 (only Rs. 1,00,000 in the first year); and (*b*) a company for marketing and small-scale finance Rs. 50,000.

(*iii*) (A) Practical training in agriculture—(*a*) under almost commercial conditions on the Fyzabad Farm, and (*b*) on departmental farms Rs. 10,000; (B) instruction in estate management.

(*iv*) Provincial Employment Board, Rs. 15,000.

(*v*) Training in certain subsidiary agricultural industries and grants-in-aid for their development, Rs. 25,000.

(*vi*) Additional provision for veterinary training, Rs. 3,000.

(*vii*) Additional provision for subsidies to rural medical practitioners, Rs. 7,000.

(*viii*) Enhancement of the amount placed at the disposal of the Board of Indian Medicine, Rs. 15,000.

(*ix*) Establishment of six centres of agricultural improvement in canal areas. (The expenditure is expected to rise to about Rs. 80,000 per annum later on), Rs. 20,000.

(*x*) Additional provision for grants-in-aid for the establishment of fined rural dispensaries, Rs. 15,000.

(*xi*) Extension of the District Health Scheme to four out of the remaining 18 districts, Rs. 55,000.

(*xii*) Revival of three travelling dispensaries, Rs. 9,000.

Establishment of Employment Boards

The above schemes have been explained in some detail in the Government communique. We give below the details regarding the proposed employment boards. The Committee recommended the establishment of Appointments Boards on the Cambridge model,—one for the products of the five universities and of institutions of a similar status, and the other for the products of Intermediate Colleges and secondary, vocational and professional schools. In pursuance of this recommendation it has been decided to set up a provincial Employment Board, composed of representatives of various interests, for both classes.

Its functions will, broadly speaking, include (*a*) collection and supply of information relating to openings for employment, (*b*) registration of candidates for appointments and bringing them to the notice of intending employers, (*c*) collection and supply of unemployment statistics, (*d*) review and coordination of the work of all agencies for employment, (*e*) keeping educational institutions in touch with matters of interest from the point of view of suitability for employment, and (*f*) advice to Government on unemployment questions.

Except in the case of those who specifically register themselves after paying the prescribed fee, the Board's functions will be general in character. The actual 'placing,' or supervision over the 'placing' of individuals will be among the duties of the appointments committees of the Universities and the Advisory School Committees attached to vocational and educational institutions.

The Board will be given a whole-time Secretary and other necessary staff. The net annual cost of maintaining such a Board is estimated at about Rs. 15,000.

Development of Air Services

Statements in the House of Commons by Sir Philip Sassoon, Under-Secretary of State for Air, reveal the magnitude of British plans for the future exploitation of Empire and world air services. Founded on the decision that from the end of 1937 onwards the bulk of all Empire first-class mail will be carried by air without surcharge, the schemes destined for fruition within the next few years are :

Nine services a week from England to Egypt.

Five services a week to India, which will be reached 2½ days out from England.

Three services a week to East Africa and Singapore, worked on a 2½ and a 4½ days schedule respectively.

Two services weekly to Australia and South Africa, the former worked on a 6 to 7 days schedule, and the latter on 4½ days.

An equal number of services will be worked on each route in the homeward direction.

Negotiations for the extension of the Australia service to New Zealand are in progress. Experimental flights directed to the establishment of a regular service across the North Atlantic are to begin later this year. Sir Warren Fisher's Committee, an official interdepartmental body to which is assigned the task of considering projects for development of external air services, has under review the possibility of a service to Latin America across the South Atlantic. Sir Philip Sassoon stated that five different groups had been invited to submit proposals for the operation of a South Atlantic service, included in which would be regular services linking England and the rest of the Empire air network with the west coast of Africa. Eventually, several undertakings, all branches of one great scheme, may represent British civil aviation in different parts of the South Atlantic.

A large fleet of aeroplanes is being built for the expanded services. At Rochester the first of 28 monoplane flying-boats designed and built by the Short company is expected to take the air soon.

Twelve large landplanes are in course of construction at the Armstrong Whitworth factory. All of the services to Africa will be worked by flying boat. The India services will be mixed—three each week to India and Singapore by flying boat, and two as far as Calcutta by landplane.

Transatlantic experiments will engage three distinct types of flying machine. First will be the flying-boat "Caledonia," one of the new Short monoplanes, which will be equipped with extra fuel tanks instead of passenger accommodation and thereby given range sufficient for operation of an air mail service across the North Atlantic by way of the Azores and Bermuda. Second will be the novel Mayo composite, or double, aircraft, which will launch in mid-air a heavily loaded seaplane capable of making the direct flight from England to Newfoundland non-stop with a big mail load. Third entrant is the D. H. Albatross four-engined monoplane, an extremely rapid craft designed on similar lines to the Comet racer. This machine, of which the Air Ministry has ordered two, is expected to cruise at more than 200 m.p.h. and to place North America within ten hours of England.

—*The Statesman.*

Problems of Indian Broadcasting

Indian broadcasting today faces a number of problems both theoretical and practical which need the co-operative work of Indian scientists in different parts of the country for solution. In our last issue we published a discussion by a group of scientists at London on a proposed radio research board for India, which will plan, direct, help, and co-ordinate all radio research in this country. In a recent issue of the *Indian Listener,* which is the official organ of the Indian State Broadcasting Service, an article has appeared appealing to the scientists all over India to co-operate with the Research Department of the Broadcasting Service in tackling the three major problems of practical broadcasting. The three problems relate to (*a*) strength of atmospheric at different frequencies, (*b*) short-wave research, and (*c*) earth conductivity. Here we give an extract from this article regarding a suggested scheme of research on the first problem.

Both scientific and lay opinion agreed that atmospherics constitute our first problem. The data available on this point is very incomplete and little work seems to have been done on the distribution of atmospherics in the frequency spectrum. What is wanted is a series of observations of the absolute strength of atmospheric noise alone at different frequencies. Diurnal and seasonal variations have also to be observed and the data tabulated before we can predict with any degree of certainty the probable service area of a station or decide the optimum band of frequencies.

The work, however, is one of great magnitude and, moreover, in a vast country like India, observations will have to be taken at a large number of centres before we can proceed on sure grounds. This is a line in which co-operation is necessary from the majority of scientific institutions and universities.

It is learned that at one of the southern universities diurnal and seasonal variations are being observed on a single frequency in the medium band. This is undoubtedly useful, but work on the complete spectrum between 150 and, say, 20,000 kilohertz would be necessary before a complete picture can be obtained Observations will be conducted at Delhi by the Research Department, and it is requested that scientific laboratories at different centres co-operate in obtaining full data. Choice of apparatus is left to individual resources, but it is suggested that measurements be taken on the following:—

Band No. 1.	Band No. 2.	Band No. 3.	Band No. 4.	Band No. 5.
150 khz	420 khz	600 khz	2,400 khz	6,800 khz
210 ,,		850 ,,	3,400 ,,	9,600 ,,
300 ,,		1,200 ,,	4,800 ,,	13,600 ,,
		1,700 ,,		19,200 ,,

It may be mentioned here that at present Bands 1 and 2 are in use only in Europe for broadcasting and are specially favoured by the U. S. S. R., who were, in fact, responsible for the opening of Band 2 for broadcasting. Band 3 is in regular use for broadcasting all over the world. Band 4 is at present not open for broadcasting but is popular in the Dutch East Indies, and according to Sir Noel Ashbridge some of the higher frequencies in this band are expected to be generally available in a year or two more. Band 5 includes most of the frequencies available for shortwave broadcasting.

It is possible that some institutions might not have the facilities for taking observations on all bands. But if the results are to be co-ordinated it would seem advisable to have one method throughout. It is suggested that measurements be made immediately after 7.00, 10.00, 13.00, 16.00, 19.00, and 22.00 hours, and that in each case observations be recorded of the field strength of atmospheric disturbances alone in microvolts per metre, the values being integrated over five-minute periods on each spot frequency. The above recommendations are, however, tentative and suggestions, for improvement are welcomed.

At the risk of being accused of stating the obvious, it must be pointed out here that the values of noise observed will depend upon the band-width of the receiver used. It will, therefore, be necessary in the case of each set of observations for the total band-width at different frequencies to be ascertained. It is also necessary that the antenna used be non-directional. Only then will it be possible to sum up all the observations from the different centres and also calculate average values for the whole of India if such a proceeding seems justified.

Rare Relics at Rajgir

The following note on the excavations at Rajgir has been issued by Mr. J. F. Blackiston, Director-General of Archaeology in India :

One of the most interesting places in India where natural beauty and historical interest combined in an unusual degree is Rajgir in the District of Patna, the ancient Rajagriha, and the earliest historical capital in Northern India. The Archaeological Department under the direction of Sir John Marshall and the late Dr. Bloch conducted some excavations at this site 30 years ago, and brought to light a circular brick structure with stucco figures in bas-relief decorating its walls, at a site in the heart of the ancient city,

The nature of this structure, which from the style of the sculptures is attributed to about 500 A.D. has been the subject of considerable speculation among scholars. Recently the area adjoining the Maniyar Math has been further examined by the Archaeological Survey, and at least two earlier strata of buildings underlying the foundations of the circular structure, which take back the antiquity of the site at least 2 or 3 centuries earlier, have been revealed. Within an enclosure of brick walls to the east of the Math, Mr. G. C. Chandra, the Superintendent of the Central Circle, discovered a surprisingly large quantity of pottery and terra cotta objects, which seem to have been purposely buried.

The most interesting type of pottery discovered here has a series of spouts numbering from 4 to 34 of various designs. A majority of the vessels bears representations of snake hoods, which confirm the idea that this site was sacred to the worship of the serpents or Nagas. The pottery with multiple spouts unknown from any other sites in India, must undoubtedly have been used in connection with Naga worship. If the name Maniyar Math faithfully preserves the memory of Mani Naga who was the protector and rain-giver of Rajagriha according to the *Mahabharata*, it may be conjectured that such vessels the multiple channels simulating showers were used by distressed supplicants praying for rain and deposited by them in the compound of the shrine. It may be noted that serpent worship, which can be traced at Rajgir from the 3rd century B.C. is still a popular form of religious belief particularly in Eastern India, as is evidenced by the widespread cult of the snake goddess Manasa in Bengal.

Madras Electric Enquiry Committee's Report

Last year the Madras Government appointed a Committee to enquire into and advise on questions connected with the electric supply industry in the presidency. (See *Science and Culture, 1*, 422). The Committee has submitted its report. The chief recommendations are summarized below. It will be noticed that the committee recommends that the Government should undertake production and bulk supply. As far as we can judge from the summaries published in the daily press, the Report is highly progressive and generally satisfactory.

The Chief recommendations of the Committee briefly summarized are :

(1) That although they do not advocate the creation of a Statutory Board at present, they are as a committee in full agreement that a Statutory Board may be desirable at some future date and recommend that Goverment should not lose sight of the possibility of such a Board being formed. (2) That an Advisory Board should be set up as soon as possible with as wide a scope as possible. (3) That a policy of steady expansion should be pursued by Government and promising large schemes taken up, especially if they exploit natural resources. (4) That generation and bulk supply should be, as far as possible by a series of large Central Government stations. (5) That subject to certain provisos local bodies should be preferred to private companies as licensees

for distribution and in certain cases for generation also. (6) That where there is no licensee in a position to do it satisfactorily, Government should undertake schemes for rural distribution provided a certain prescribed standard of gross return is satisfied. (7) That powers should be taken to enforce closer control over licensees in certain matters. (8) That power should be taken by Government to enforce the closing down of small uneconomic stations when bulk supply becomes available. (9) That the Electrical Inspector should again be separated from the Chief Engineer with appropriate rank and wider responsibility. (10) That the question of drafting a simplified and self-contained Account code for the Electricity Department should be taken up. (11) That methods of recruitment and promotion of technical staff should be examined with a view to modification where necessary.

H. E. the Viceroy on Nutritional Research

In course of his speech opening the meeting of the Nutrition Advisory Committee of the Indian Research Fund Association, Lord Linlithgow stressed the necessity of establishing a link between research on the problems of human nutrition and agricultural research. He also said that time has come when efforts should be made to spread among the lay public and the masses the knowledge acquired by recent researches.

"In no country is the subject of greater importance than India. I rejoice to find that during the last ten years public opinion in this country has shown an ever-growing interest in the problems of human nutrition, and I am persuaded that the time has come when all concerned should apply themselves with renewed energy and enthusiasm, not only to the active prosecution of research in this field, but also to the practical application in the homes of the people of the fruits of that research in terms of the diet of the population, both in the rural areas and in the town.

"The Royal Commission on Agriculture envisaged the setting up of a Central Institute of Human Nutrition, but lack of funds has hitherto prevented the implementing of that recommendation.

"The Commission also advised that a link should be established between research on the problems of human nutrition and agricultural research. I have faith that the future will witness the founding of such a Central Institute of Human Nutrition. Meantime, I invite you to consider at this meeting the expediency of establishing a point of contact between these two branches of science.

"Agricultural research will shortly be in full swing at the new Imperial Institute of Agricultural Research at Delhi. I suggest to you that the inauguration of this station affords an excellent opportunity to create a permanent liaison between research workers in human nutrition and those engaged in agricultural research by the appointment of an expert in human nutrition to work in the Delhi Agricultural Institute. I have no doubt that such an appointment would be welcomed by the whole staff of agricultural research workers, and I am confident that such an arrangement would prove to be of substantial value to all concerned.

"I said a moment ago that in my opinion the time has come to press forward with the difficult matter of making available to the general public the fruits of research on human nutrition. This of course, is a function that belongs to the provincial Governments and their officers. I cannot but feel that here is an opportunity for the further exploitation of that principle of joint endeavour between the provinces and Central Research Institutions, which is so happily exemplified in the existing arrangements for agricultural research. The Nutrition Institutes at Coonoor and Calcutta already have to their credit much work of the utmost value. It is my earnest hope that the provinces will make the fullest use of that material and that they will suggest for investigation by the Central Institutes any special problems with which they may be confronted.

Improvement of India's Dairy Trade

The Government of India have decided to separate the organization under the Imperial Dairy Expert which will henceforce deal directly with the Education, Health and Lands Department of the Government, and not under the Imperial Council of Agricultural Research, Pusa, as hitherto. This decision has been arrived at with a view to keep the developement of dairying and animal products on proper lines.

The scheme will provide for National Research Creamery, where processes of manufacturing evaporated and powdered milk, casein, etc., on a factory scale will be experimented on and standardized, thus providing a stimulus to industrial dairying. The need for such an institution can be gathered from the fact that India to-day imports milk products in the form of condensed milk and milk powder and other dry milk preparations of the value of about Rs. 2,00,00,000 annually. The scheme referred to will also aim at the expansion of the Central Institute of Dairy Husbandry, Bangalore, by providing, as far as possible, with extra lands, laboratory facilities, etc. With a nucleus like this for the new Dairy Department and the various other schemes sanctioned by the Imperial Council of Agricultural Research, a vigorous start has been made, and very important developments are contemplated in the near future.

The standard of training given in dairying at present is to be raised so that it will be as high as any given in any other part of the world. The advisory and propaganda work will be much more intensified to meet with the full demand of the trade and in order that the development can be efficiently carried out the Government of India have approached the Provincial Governments for their full co-operation. Sub-stations to the main institution located in the more important parts of the country are contemplated in the future development programme, so that the Dairy Industry will have that guidance and support from the State which is so necessary for its proper development. With a central organization started on such a foundation and with what the Provinces will be providing, working in close co-operation with one another, it is expected that before long India will have a mechinery to cater for the needs of this nation-building industry, which can compare favourably with the best of its kind in any other country of the world. Time, finance, awakening of public interest, and methodical organization under the guidance of experts in the line are some of the factors which are necessary in producing the results, and the Imperial Council of Agricultural Research is doing its best to bring this about.

Blood from the Dead

Blood from the bodies of those who die suddenly—in automobile accidents, by electrocution or by drowning, for example—is being used in Russia for transfusion in human beings. Almost 1,000 transfusions of blood from the newly dead have been made at the surgical clinic of the Institute Sklyfasovsky Central Emergency Hospital, Moscow.

S. S. Yudin, surgeon-in-chief, describes the striking results obtained in these cases and the technique employed in transfusion in the *Journal of the American Medical Associations.* Blood must be obtained from six to eight hours after death. The recipient of the blood is safeguarded by serologic tests of the blood, a bacteriologic check-up and a careful autopsy.

In those who die suddenly, the blood remains fluid and can be preserved at low temperatures for more than three weeks, the Russians have found. In its healing effects, this blood does not differ from the blood of living donors. As sources of supply, Dr. Yudin suggests victims of traffic accidents as well as hospital patients who die from coronary thrombosis and angina pectoris. The blood is warmed to body temperature by placing a flask of it in warm water. It is then passed through a gauze filter into the vessel from which it is be transferred.

The advantage of the method is that there is no loss of time in acute emergencies, for it is unnecessary to call in a blood donor. Another valuable feature is that blood from the same cadaver can be used for repeated transfusions in the same patient. Sometimes several transfusions are necessary during a single operation.

—*Scientific American*, June 1936.

Jubilee of the Indian Science Congress

The British Association of Great Britain, it is understood, has for the first time decided to hold a joint session with the Indian Science Congress in January, 1938, and in India.

The occasion will be particularly memorable for this country because it will celebrate the jubilee of the Indian Science Congress. For climatic reasons and partly owing to the fact that it has already accepted the invitation to hold its session in 1938 in Great Britain, the British Association cannot partake in the joint session in India fully and has, therefore, decided to send to India a strong delegation of prominent scientists. About 50 scientists are expected to attend the session. Some of these are coming from outside the British Empire.

The Indian Science Congress, it is understood, is making necessary efforts to take advantage of the presence of these distinguished men with a view to bring them into contact with scientific workers in different centres in India. This arrangement, it is expected, will give an impetus to scientific activity in India.

Whenever the British Association holds its session in a Dominion, the latter makes a handsome contribution towards the expenses of the session. The Indian Science Congress approached the Government of India for a similar contribution and its is understood that Sir Jagadish Prasad, Member-in-charge of Education, Health and Lands, has promised to consider the subject sympathetically.

Letters have been received by the universities in India from the Indian Science Congress, explaining the significance and importance of the session and it is understood that already two universities have sent invitations to the Congress to hold its joint session with the British Association under their auspices. They have intimated that, if their invitation is accepted, they would supplement the Government grant for expenses.

Apart from these two universities, it is expected that financial assistance to the Indian Science Congress will be forthcoming from other universities and Princes and also from private individuals.

It is understood that His Excellency the Marquess of Linlithgow has consented to be the patron of the joint session.

The Syndicate of Calcutta University has considered the subject and has informed the authorities of the Indian Science Congress that Calcutta University will be glad to invite the joint session of the Indian Science Congress and the British Association under their auspices and will recommend to the Senate of the University a special grant of Rs. 5,000 for the purpose.

The University has been informed by the authorities of the Indian Science Congress that the total expenditure to hold the joint session will be about Rs. 1,10,000 towards which a contribution of Rs. 60,000 is expected from the British Association and the remaining amount is to be raised in India.

—*The Statesman.*

Lady Tata Memorial Trust

The Trustees of the Lady Tata Memorial Trust announce the awards of the following scholarships and grants for the year 1936-37 :—

I. *International Awards for research in diseases of the blood with special reference to Leukaemias.*

(1) Dr. Charles Oberling of French Nationality, Professor Agrege of the Faculty of Medicine, Paris, and Director of the Department of Experimental Medicine in the Institute of Cancer, Paris, to continue research in the Transmissible Leucaemias of hens and their relationship to the Sarcomas, under the direction of Professor G. Roussy, Professor of Pathology in the Faculty Medicine, Paris. (Grant of £400—Fourth Year's Award).

(2) Dr. Julius Engelberth Holm of Danish nationality, Scientific Assistant at the Finsen Institute, Copenhagen, to continue research on virus of hen Leukaemias together with Therapeutic investigations, under the direction of Professor Dr. Olud Thomsen, Director of the Institute of General Pathology, University of Copenhagen. (Grant of £400—Third Year's Award).

(3) Dr. Lucy Wills of British Nationality, Lecturer in Chemical Pathology at the Royal Free Hospital and Research worker at the London School of Hygiene and Tropical Medicine, London, to continue research in the Macrocytic nutritional anaemia of monkeys with reference to tropical macrocytic anaemia in men and also to investigate generation of blood by yeast treatment and the chemical nature of haemopoietic fraction present in Yeast, under the direction of Prof. W. W. C. Topley, Director, Department of Bacteriology and Prof. H. Raistric, Director, Department of Biochemistry at the London School of Hygiene and Tropical Medicine. (Grant of £400—Third Year's Award).

(4) Dr. Max Otto Kaalund-Jorgensen of Danish nationality, Assistant in the University Skin and Venereal Clinic at Copenhagen, to continue the study of Leukaemia and on the cultivation of leukaemia cells and myelomata 'in vitro,' under the direction of Dr. Albert Fischer, Director of the Carlsberg-fondets Biological Institute. (Grant of £300 —Third Year's Award).

(5) Professor Eugene L. Opie of American nationality, Cornell University Medical College, New York, to continue the work in progress upon the Leukaemias like diseases of fowls and their relation to neoplasms, and to determine the nature of viruses producing leukaemias and associated neoplasms lymphomatosis, myelomatosis, endothelioma, sarcomas, etc. (Grant of £400—Second Year's Award).

(6) Dr. Phil Karl Hinsberg of German nationality, Director of the Department of Chemistry, Pathological Institute, Berlin, to investigate the metabolism of fat, copper and glutathione in leukaemias, under Professor R. Rossle, Director Charite Krankenhaus, Berlin University, Berlin. (Grant of £800—Second Year's Award).

(7) Professor J. McIntosh of British nationality and of the Middlesex Hospital, London, to assist a combined clinical and pathological investigation of human leukaemias. (Grant of £200—First Year's Award).

II. *Indian Scholarships of the value of Rs. 150 per month each for scientific investigations having a bearing on the alleviation of human suffering :*

(1) Mr. Madhab Chandra Nath, M.Sc., to continue the Chemical and Biological analysis of Proteins of Indian Foodstuffs, under the direction of Dr. K. P. Basu, D.Sc., Bio-Chemist, Dacca University. (Third Year's Award).

(2) Mr. Ramkanta Chakraborty, M.Sc., (Dacca) to continue the investigation of nutritional problems of Indian foodstuffs with special reference to Vitamin C, under the direction of Professor H. Ghosh, Director, Indian Institute of Medical Research, Calcutta. (Second Year's Award).

(3) Mr. Nalin Bandhu Das, B.Sc., (Calcutta) to continue the work on the Oxytocic hormone and on Oxidation-Reduction systems in the body under the direction of Professor Szent-Gyorgyi at the Institute for Medical Chemistry in the University of Szeged, Hungary. (Second Year's Award).

(4) Mr. Tejendra Nath Ghosh, M.Sc., (Dacca), A.I.I.Sc. to continue the research on the preparation of New Anti-malarials under the direction of Dr. P. C. Guha, D.Sc., Professor, Department of Organic Chemistry, Indian Institute of Science, Bangalore. (Second Year's Award).

(5) Dr. Birendra Kumar Nandi, M.Sc., Ph.D., A.I.C. to continue the work on synthesis of anti-malarials on the line of plasmochin and atebrin types under the direction of Professor R. Robinson, D.Sc., F.R.S., at the Dyson Perrins Laboratory, Oxford University, Oxford (Second Year's Award).

(6) Mr. Harbhajan Singh Mahal. M.Sc., Lahore, to work on the Role of "Choline Esterase" in Physiology and Pathology and to continue the work on anthelmintics synthesis of substances and examination of Indian Plants having anthelmintic properties, under the direction of Dr. B. B. Dikshit, Department of Pharmocology, Haffkine Institute, Parle, Bombay (Second Year's Award—only for the first six months).

Standardization of Intelligence Tests

Elsewhere in this issue we publish a letter in which Mr. B. Ghosh has put forward a strong plea for standardizing intelligence and vocational tests for Indian boys. We wish to draw the attention of the Indian psychologists to this very important question discussed in this letter. We hope that in near future some practical steps will be taken in this direction by the Indian Science Congress or the Indian Psychological Association.

Research Notes

Cercospora Leaf Spot in Bananas

Studies in the leaf spot disease in Bananas has been reported in the *Agricultural Gazette of New South Wales* XLVII Part I. The disease is caused by the fungus *Cercospora musae* Zimm. "The first indication of infection is the appearance of brown, longitudinal markings running parallel with the veins and scattered over the upper surface of the leaf blades. The spots increase in size up to ½ inch or more in length, become lenticular to irregular in form, dry out and become black. Later the spots turn greyish white in the centre, but their margins remain black. At this stage many of the spots are surrounded by a bright yellow-coloured zone or halo. Close inspection reveals the presence of black specks in the greyish centre of the spots, and it is on these that spores of the fungus are borne in profusion."

Seasonal conditions appear to play an important part in determining the severity of the disease. High humidities and temperatures as prevail during the cooler months are responsible for rapid development and spore production. High temperatures and lower humidities keep the disease in check.

No satisfactory method of control has been discovered. The use of fungicidal dusts and the removal of affected leaves and trash have been tried but without success.

I. Banerji.

Neutron Capture and Nuclear Constitution

Very recently a number of interesting observations in connection with collisions of neutrons with atomic nuclei have been made by Fermi and his co-workers and also from some other laboratories. For their explanations the usual quantum mechanical picture of the nucleus has been found to be inadequate as discussed by Prof. Niels Bohr, in an address delivered on Jan. 27 before the Copenhagen Academy (*Nature 137*, 344, 1936). Extreme sharpness of the lines of the emitted γ-rays as well as the life periods of radioactivity produced by neutron capture shows that the lifetime of the excited nuclear states involved in such artificial activity is extremely long compared with the time required by the neutron in passing through a space region of nuclear dimensions.

This is explained by Bohr as due to the sharing of the energy of the incident neutron by the nucleus as a whole and its rising to a higher energy state. Emission occurs in a later process when sufficient energy is perchance concentrated on a particle at the surface of the nucleus.

Another observation is the selective capture of slow neutrons as against the continuous absorption of fast neutrons. This is explained by Prof. Bohr as a quantum mechanical resonance phenomenon. The successive energy levels which are further apart at lower levels close up together at higher levels. When there is coincidence between the energy of the incident neutron and the energy difference of two levels capture occurs. At lower excitations where sharp differentiations of energy levels are possible, the absorption is selective while at higher states of excitations, absorption is continuous as energy levels are too close to be differentiated.

K. B.

New Light on the Indus Valley Civilization

A discovery of unusual interest has recently been made by Dr. Hellmut de Terra, the leader of the Yale-Cambridge India Expedition and described in the *Miscellanea* of the American Philosophical Society just issued. In the course of his excavations at the Megalithic site of Burzahom near Srinagar in Kashmir, numerous polished stone implements and a 'black burnished' ceramic ware were found at a depth of 11 feet from the ground level below a bricklain kitchen floor containing clay hearths. The pottery is similar to the 'band ceramic' of Central Europe and regarded by Dr. de Terra to be late Neolithic of approximately between 3,500 to 4,000 B. C. It is significant that this 'black burnished' pottery is identical with the black ware found in Mohenjodaro and not dissimilar to the black ware found mixed with the painted pottery of the earlier Chalcolithic periods of Baluchistan and

Persia. Mr. Paterson, another member of the Yale-Cambridge India Expedition, has found it in a kitchen hidden in the lower Sind valley.

This important discovery definitely establishes the existence of a late Neolithic culture underlying the Mohenjodaro civilization, linked up with the Megalithic culture of Kashmir and N. W. India. The Indus civilization as disclosed in the upper strata of Mohenjodaro and Harappa may therefore be taken to be a later intrusion. How much the latter absorbed cultural elements from the former and how the two stood in relation to each other are questions that cannot be settled until the Megalithic remains of Sind, especially the neighbouring ones on the Rorhi Hills, are excavated. A careful exploration of the sites is therefore urgently called for.

B. S. Guha.

On Indian Culture

In the interesting presidential address to the First Indian Culture Conference held recently at Calcutta under the auspices of the Indian Research Institute (published by the Indian Research Institute) Dr. D. R. Bhandarkar, M.A., Ph.D., F.A.S.B., Carmichael Professor of Ancient Indian History & Culture in the University of Calcutta, has lucidly pointed out the intrinsic qualities of Indian culture. He has divided the sphere of remumé into three periods, viz., ancient, mediaeval and modern. In course of dealing with the ancient period he has rightly remarked that "the art and religion that blossomed in India in historic times were as much a legacy of the Chalcolithic Culture of the Indus Valley as that of the Aryan Culture of India." (p. 10). But the most interesting and important point which he has ably shown is regarding the second period. It is a general belief among the educated people that the Moslem rulers of India indiscriminately destroyed everything which is related to Hinduism and that there was no bond of fellowship between the Hindus and the Moslems during this period; but that this is a wholly mistaken conception of the Hindu-Moslem relations has been rightly pointed out by the learned author. He has given many interesting and conclusive evidences to show that there was a real fusion of Hindu-Moslem thought and culture in this period. To take a few examples, Nanak's sermon, "There are neither Hindus nor Musalmans" and the utterance of Rajjab, a Musalman and the chief disciple of Dádu, the Hindu religious reformer, which runs, "All the world is Veda, and all creation the Koran"—point to this conclusion. We hope that some scholar will take up this problem suggested by Dr. Bhandarkar and will work up a thesis which will do a good deal in driving away the wrong idea about the Hindu-Moslem relations. Dealing with the third period the author has pointed out that India will become a nation with a responsible self-government through Pax Britannica.

C. C. Das Gupta..

On a Line of Brahmi (?) Script in a Babylonian Contract Tablet

In an interesting communication published recently (*Journal of the American Oriental Society*, vol. 56, pp. 86-88, pl. 1, 1936) Mr. G. V. Bobrinskoy of the University of Chicago desires to show that there is a line of *Brahmi*(?) script in a contract tablet from Babylon which records the sale of a slave-girl and is dated in the 23rd year of Artaxerxes. He has referred this tablet to the reign of Artaxerxes I and therefore the date of this tablet becomes 441 B.C. As the preceding four lines of the cuneiform contain names of apparently Babylonian witnesses to this transaction of the sale of a slave-girl, the author believes that this line of *Brahmi*(?) script possibly contains the name (or names) of a witness (or witnesses) to this transaction. In this line there are apparently fourteen letters and he has suggested the following tentative reading : —*ma kha ha ra kha da* or *do ma ja* or *ta mu . ta* . . . He has further suggested that *màkha* may be the first part of a name (compare *pali Makhadeva*). In the concluding sections the author has remarked, "In spite of the difficulties here outlined, I am convinced that we have here some kind of a *Brahmi* script, even though differing considerably from the type found in the Aśokan inscriptions. These difficulties can be easily accounted for by the early date of our tablet." (p. 88). He has rightly opined that the presence of a form of the *Brahmi* script in Babylon in this period does not produce any difficulty as we know definitely that the Indus Valley and some parts of the Punjab were within the Persian Empire during this period. This inscription is certainly unique and, as the author himself admits, his reading cannot be taken as final. I wish to draw the attention of all Indologists to this unique record for better and fuller reading and interpretation if that be possible.

C. C. Das Gupta.

Citrus Diseases in the Panjab

According to Dr. Chaudhuri (*Ind. Jour. Agric. Sci.* VI, 72, 1936) the following three diseases of the valuable citrus fruits (oranges, lemons etc.) are commonly met with in the Punjab. (1) Wither tip, caused by *Colletotrichum gloeosporioides*, (2) chlorosis and (3) sooty mould. The wither tip disease, which is found all over India as a minor disease, has become a major one in the Punjab where it is even epidemic on "santara" and "malta" oranges. The chief symptoms are a gradual withering from tip downwards and dropping of fruits. Trees previously weakened by unfavourable soil, low temperature and frost, are specially liable to be attacked and the injuries are generally severe if accompanied by other fungi. Four strains of the causal organism have been found and they show decided differences in virulence and growth in artificial culture. The fungus lives on dead twigs and can be kept at O°C for more than one and a half months without injury. Pruning and burning of diseased parts are, therefore, necessary as salutary measures. No resistant variety has been found but a susceptible variety like "malta" becomes somewhat resistant when grafted on "kimb" as stock but remains susceptible if the "khatta" variety is used as the stock. The varieties "khatti" "turang" "kimb" and "eureka" are recommended as suitable stocks for "malta" and "santara" oranges. Spraying with Bordeaux-oil emulsion shows marked improvement with fruitfall checked and in a trial experiment with 380 plants sprayed with 825 gallons of the fungicide, the cost including labour worked out at 9 pies per tree. In chlorosis the leaves become mottled and drop down early. Spraying with a .0001% solution of ferrous sulphate gives good results. The sooty moulds do no damage but the affected fruits taste bitter and Bordeaux mixture is the preventive. The naming of the Indian varieties of this fruit by Prof. Tanaka may be helpful in clearing the confusion existing about the identity and classification of these.

A. M.

Teracottas from Patna

In an interesting communication entitled "Terracottas dug out at Patna" (*Journal of the Indian Society of Oriental Art*, vol. III., pp. 125-26, pls. XXX-XXXII, 1935) Mr. K. P. Jayaswal M.A., Bar-at-law, has described and illustrated some interesting terracotta figurines recently unearthed at Kadamkuan, Bakarganj, Bhiknapahari, Mussallapur and Golakhpur near the modern city of Patna. It is interesting to note that in Kadamkuan a Brahmi inscription of the Asokan age has been found at a depth of 14 feet. Regarding the important question of the Maurya level at ancient sites near Patna the author observes, "The general Mauryan level from earlier coin-finds (Golakhpur 15 feet) and other experiences of mine extending over twenty-one years at Patna is 14 to 12 feet." On the consideration of this hypothesis some of these figurines have been placed in the pre-Maurya age, others in the Maurya age and one in the 2nd century A.D. One female torso (pl. XXXI.) is particularly interesting from the aesthetic point of view.

C. C. Das Gupta.

Phytin in Human Nutrition

It has long been recognised that a large proportion of the total phosphorous of cereals and other vegetable food-stuffs may be present in the form of Phytin, the calcium magnesium salt of inositolhexaphosphoric acid. This compound has been considered to be so important that it is commercially manufactured and has been widely recommended and accepted as a tonic and as a readily assimilable form of phosphorous for human nutrition. But evidence has been accumulating in recent years that its phosphorous is not available.

McCance and Widdowson (*Biochem. J.*, 29, 2694) have taken up the investigation of the fate of ingested Phytin on human subjects, two males and two females. The subjects were fed on diet whose Phytin content was known. The amount of Phytin excreted was quantitatively determined by stool analysis. The authors claim that their experiment provides concrete evidence that fifty per cent of the Phytin phosphorous comes out in the faeces. The authors state that in their country (England) where they live on a varied diet and derive most of their phosphorous from animal and not from vegetable sources, 80-100 per cent of the total phosphorous eaten is in available form. But in countries like India where cereals, either whole or milled, constitute by far the largest portion of the diet the total phosphorous in the diet consumed may be a wholly incorrect guide to available phosphorous intake. So even large amount of phosphorous taken as vegetables may be wholly useless from the point of view of nutrition.

H. N. Banerjee.

The coming of Iron

Man must have come to know of iron through meteorites. It was therefore thought to be connected with other things which fell from heaven : like the 'thunder-stone' it was sacred and of great potency against evil spirits. These are the conclusions of G. A. Wainwright, writing in *Antiquity, 10, 5*f, 1936.

According to the writer, iron is first met with in Egypt in about B.C. 3500 and at Ur (Mesopotamia) in B.C. 3000-3500. But in both cases, there is a good percentage of nickel in the iron, which conclusively shows that the metal was of meteoric origin, for it is the inclusion of nickel which distinguishes meteoric from terrestrial iron. There are evidences for the use of smelted iron in Mesopotamia some time before B.C. 2600, but until B.C. 1100 iron was as rare here as in Egypt. Even in the first century A.D. iron was known to the Egyptians as the bone of the storm god. From the 15th to the 18th centuries B.C. iron was introduced in Syria and Palestine. In Greece, though there was occasional use of the metal in B.C. 1500, the passage from bronze to iron took place in about B.C. 1100. But in Asia Minor iron was common from the 20th century B.C. and there were some peoples who made iron-working their national industry. From this country the use of iron began to spread in all directions from at least B.C. 1460, as a result of trade and migrations.

A. Ghosh.

An Example to Others

Sir Herbert Austin has given £250,000 for scientific research at Cambridge. Lord Rutherford, director of the Cavendish Laboratory, in expressing his gratification at this generous gift and recognition of the work done in the past by Sir J. J. Thomson and his colleagues at the Cavendish Laboratory, said that the donation would give them an opportunity of building a modern research laboratory and would also be of great value in helping to defray the lage expenditure required on modern research in physics, which often involved the use of apparatus on a costly scale. The first use of the money would be to build a laboratory for the utilization of very high voltages, in order to carry out experiments on the transmutation of matter by highspeed particles and by radiation. *The Times* in a leading article entitled "A princely Gift to Science," remarked that to say that the Cavendish has immensely increased our knowledge of Nature is to tell only half the story. "The physicist's work on the electrical conductivity of gases has laid the foundation of at least two great industries—wireless transmission and illuminated signs. Measured by the lowest of all tests, the Cavendish has been a highly profitable investment. Industry in general can show gratitude to pure science in general by providing it with means for continued and expanded existence. That is what Sir Herbert Austin has done. He has shown wisdom as well as generosity by selecting fundamental researches for his munificence. His gift is an example to others."

—The Electrician.

Book Review

Pheretima *(The Indian Earthworm).—By K. N. Bahl. (Second Edition). The Indian Zoological Memoirs on Indian Animal Types Edited by K. N. Bahl. No. 1. With 7 plates and 28 text-figures. Rs. 1-8.*

This well-known memoir which was the first of the series of Indian Zoological Memoirs, was first published in 1926 and has been widely used and appreciated during the last ten years. The new edition that has just appeared is more comprehensive in scope and contains much new material and several new illustrations. The high standard set up by the first edition has been still further enhanced in this revised edition.

A notable addition in the introductory chapter is the classification, with keys to the families of the Oligochaeta and subfamilies of the Megascolecidae and a synopsis of the Indian species of *Pheretima*.. In the descriptions of the various systems, a welcome addition is an account of their physiology. The physiology of digestion is particularly interesting in that the saliva contains mucin and a proteolytic ferment; the mucin lubricates the food and the proteolytic ferment starts the digestion of proteins. Several ferments have also been found in the intestine. The microphotograph of a vertical section through the first sixteen segments (p. 29) is excellent and shows the anatomy of this region at a glance. The accounts of the vascular and excretory systems are particularly full on account of the author's own published contributions. A diagrammatic representation of the paired nephridia in *Lumbricus* is an addition which will enable the elementary student to understand the remarkable difference in the excretory systems of the two common earthworms of the West and the East.

In the chapter on the nervous system, a fuller account is given of the nerve fibres, and the diagram of the chain of the nervous elements in the nerve-cord shows the simple circuit of impulses forming a reflex arc as well as the condition of stimuli throughout the cord. The term "receptor organs" is rightly substituted for the older term "sense organs" and they are described in a separate chapter as epidermal and buccal receptors and photoreceptors. On the conjugation of *Eutyphaeus* Dr. Bahl presents his own observations published in 1927. This earthworm conjugates during the monsoon (July, August and September) and shows the simplest and the most direct method of transference of sperms known in earthworms. In *Pheretima*, however, the processes of conjugation and cocoon formation have not yet been followed but cocoon formation probably takes place throughout the year, if there is sufficient moisture in the soil. The chapter on Bionomics, Distribution, and Relationships gives an adequate idea of the life of the earthworm as a whole and the photographs of the castings of *Pheretima* and *Eutyphaeus* are particularly interesting.

These valuable memoirs, of which *five* have so far been published, are now a regular feature of teaching in Indian zoological laboratories and truly form a landmark in Indian Zoology. The author-editor deserves to be congratulated on the publication of the second edition of his own memoir and on his very successful editorship of the whole series.

H. R. Mehra.

A Text Book of Heat (for beginners)—*By K. P. Ghosh, M.Sc., Published by the Indian Press Limited, Allahabad, (pp. 239 + 250 illustrations) Price 2-8-0.*

Mr. K. P. Ghosh who has already written a number of text-books for the intermediate science students has made this fresh endeavour. The general get-up of this text-book of heat has very little to be commented upon. The printing and quality of the illustrations call for special praise.

Mr. Ghosh introduces his subject with a brief review of the kinetic theory of matter and in the subsequent developments has chosen kinetic theory to be the corner stone. It is no doubt a very reasonable standpoint for the development of the subject of heat for beginners, but the introduction of the Brownian motion at the very outset seems to be too much for the young learners who have crossed over the threshold of the school final or matriculation examination.

The chapters on thermometry, calorimetry, and expansion of solids have been very nicely developed but the reviewer fails to understand why Lavoisier's experiment has been omitted.

The chapters on 'Real Gases' and 'Hygrometry' (dealing with the study of fogs, etc.) seem to be the best-written chapters in the whole treatise. The description of various methods of liquefaction of gases and their gradual stages of development have been arranged in a very methodical way : especially, the paragraph on the temperatures below 1° K gives very interesting recent results.

In the whole book only one block illustrating the land breeze (page 254) seems to be very disappointing; it does not carry any impression to the reader.

In treating the subject of conduction and convection, the author seems to have spared the students a good deal of learned discourses and advanced methods.

The chapter on Heat Engines which has been written by one of the former students of the author seems to contain more material than is required by the degree students of some of the Indian universities. The reviewer fails to understand the merit of the inclusion of the indicator diagrams (given within parantheses) without attaching its proper theoretical importance.

The text is pleasant to read and gives an up-to-date review of the main principles of the subject. On the whole, a text book of this type—a text book in the true sense of the term—should be welcomed by teachers and students alike. It may be hoped that the book will prove to be very popular among the intermediate science students of Indian colleges, for whom it is meant.

H. P. D.

In SCIENCE AND CULTURE, *1*, page 779, 2nd column, line 15 *for* "a less" *read* "an", *and* in lines 17-18 *for* "curative value deficiency" *read* "curative value for vitamin deficiency".

In the table on the next page (780) the figures in the 6th and 7th columns, from line 19 onwards (62.5, 82........81.5, 92) should be shifted a little to the right so as to bring them under the dates 24.4.36 and 8.5.36.

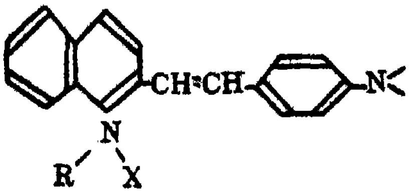
Letters to the Editor

[The views expressed in the letters are not necessarily those of the Editor].

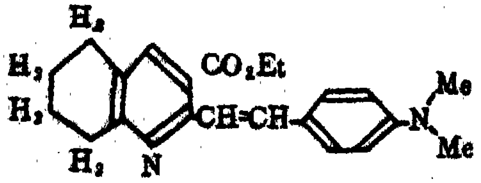
Chemotherapeutic Studies in the Bz-tetrahydroquinoline series. Part I

A SYSTEMATIC chemotherapeutic study of the newly synthesized benzo-pyridine derivatives,[1] the search for which was stimulated by the isolation of 1-oxy 3-keto 4-cyano 2:3:4:5:6:7:8-hexahydro isoquinoline[2] possessing a considerable pharmacological activity (an unpublished work), seems now to be of considerable importance.

In the literature which has special reference to the relation existing between the chemical constitution and therapeutic effectiveness of heterocyclic derivatives of the above nature, the researches[3] of Browning and his co-workers are noteworthy. They have made an extensive investigation on the bactericidal properties of various quinolines and their derivatives, and have come to the conclusion that for the development of bactericidal activity, the compound should contain at least a trivalent basic nitrogen atom chained by the alternating double linkage, to another nitrogen of pentavalent nature, or in other words, it would be of the type (1).

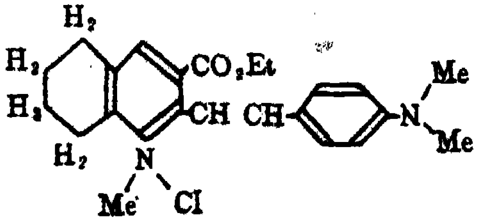


A class of compounds belonging to the above type is now being synthesized by the action of appropriate aromatic aldehydes on Bz-tetrahydroquinaldine derivatives. Thus, ethyl 2-methyl Bz-tetrahydroquinoline-3-carboxylate reacts with p-dimethyl amino benzaldehyde in presence of zinc chloride to give rise to ethyl 2—(p-dimethylamino styryl) Bz-tetrahydroquinoline 3-carboxylate (II) (deep yellow needles m.p. 120°). This, on heating



II

with dimethylsulphate affords the corresponding methosulphate (m.p. 184°) (extremely soluble in hydrated solvents). An aqueous solution of the latter substance, on treatment with a saturated solution of sodium chloride gives the methochloride (III) m.p. 254°. It might be



III

observed from this structure that the styryl derivative is of the general contour shown in (I) and as such, might be expected to exert a considerable antiseptic action and even, to possess certain definite trypanocidal properties in the organism.[4]

Experiments on similar lines are in progress and a study on the antiseptic, trypanocidal and other physiological characteristics of this new class of compounds is being undertaken.

U. Basu.

Research Laboratory,
Bengal Immunity Co., Ltd.,
Barnagore, Calcutta.
11-6-1936.

1. U. Basu, *Annalen*, **512**, 131, 1934 ; **514**, 292, 1934 ; **516**, 243, 1935.
2. U. Basu, *J. Indian Chem. Soc.*, **8**, 324, 1931.
3. *Brit. Med. J.* II, 695, 1921 ; *Proc. Roy. Soc. B.*, **93**, 329, 1922 ; **96**, 317, 1924 ; **100**, 293, 1926 and subsequent papers.
4. Browning and others, *J. Path. Bact.* **29**, 317, 1926 ; **31**, 134, 1928 ; **34**, 592, 1931.

Sankalu Seeds as Fish Poison

In a note previously published[1] on Some Rat-Feeding Experiments with *ohkola*, *sankalu* seeds and soja bean attention was drawn to the injurious effect of *sankalu* seeds as food for rats. In view of the above finding, we were interested to examine the effect of *sankalu* seed extracts on fish.

It was found that 0.1% of seed powder in tapwater killed fishes like *tengra*, *shing* and *kai* within thirty minutes.

In another set of experiments the powdered seeds were thoroughly extracted with ether and the effect of the oil free seed powder was found to be even more effective in killing fish.

In a further set of experiments the ether extracted seed powder was exhaustively re-extracted with boiling rectified spirit (91%). In this case the seed powder, after alcohol extraction, mixed with water, had absolutely no toxic effect on the fishes.

The Alcoholic Extract.—The alcohol was thoroughly removed and the residue dissolved in water to 0.02%, 0.01% and 0.002% strengths. The results are tabulated below :—

Strength of Solution.	Time taken to kill a fish.
0.02 %	17 minutes
0.01 %	18 minutes
0.002%	60 minutes

From the above details it will be evident that there is a powerful toxic principle in the *sankalu* seeds and that this is completely removed by boiling alcohol, leaving the powder perfectly harmless. The toxic substance is soluble in water and answers to some of the saponin reactions.

It may be remarked in passing that *chhola* powder is perfectly harmless in this respect.

Further details will be published later on.

H. N. Nag.
H. N. Banerjee.
A. K. Pain.

Bose Research Institute Laboratories,
Falta and Calcutta.
10-6-1936.

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1. Nag, Banerjee and Pain. SCIENCE AND CULTURE, *1*, 779 1936.

Raman Effect in Arsenates and Heat of Dissociation of As—O

Since the discovery of the Raman Effect, several organic and inorganic substances have been studied from time to time with the object of interpreting the frequency shifts in terms of their constitution. The co-relation of the frequency shifts in the case of inorganic compounds with the groupings of atoms and their characteristic oscillation frequencies was first brought about by the works of Pringshiem, Rosen, and Carelli[1] on several inorganic nitrates in solution, since then the same results were virtually obtained by other investigators.

As regards the investigation of salts containing ion of the type XO_4, it was carried out successfully by Krishmurty[2] and others, but a few gaps i.e. (AsO_4 etc.) still remain to be investigated systematically.

Recently we have investigated a number of arsenates in solution. All of them give identical Raman lines, thereby clearly pointing out that they are due to the AsO_4 ion. Four lines appear in all one of which is strong corresponding to a shift of 837 Cm^{-1} and two others at 349, and 465^{-1} of medium intensity and another very feeble at 878.

If we compare the result with that of SO_4 ion we find a close resemblance between the two. Presumably like the sulphate ion, the arsenate has a tetrahedral structure —the four O forming the corner of a regular tetrahedron with As at the centre and the four Raman frequencies would then correspond to the four fundamental modes of vibration dynamically possible for such a model the strong line corresponding to 837 Cm^{-1} is due to the totally symmetrical vibration of the tetrahedral model.

In the usual way, we have calculated the heat of dissociation corresponding to the bond As—O, it came out to be 112 K Cal. per mol. in splendid agreement with that deduced from the known thermochemical data. (110 K. Cal. per mol.)

Details will be published in due course.

In conclusion, the undersigned thanks Prof. S. N. Bose for his kind interest in the work.

S. M. Mitra.

Physics Laboratory,
Dacca University.
11. 6. 36.

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1. *Zeit. Phy. 51*, 511, 1928.
2. *Ind. J. Phy. 5*, 633, 1930.

Fruit Storage and Transport

This note is intended to draw the attention of the fruit growers to the desirability of starting research work in this country on the preservation of fruits. Take for example, mangoes or guavas, if these fruits can be stored for ove rsix months and transported elsewhere, then the fruit growers will obtain more money from the same amount of fruits. Imagine fresh mangoes selling in winter, or fresh guavas in summer, or mangoes and guavas being transported to various countries. Oranges will also be greatly appreciated in the months of June and July.

One way to make use of surplus stock of fruits is to make jellies and *chutneys*, but these do not pay as much as the green fruit. Hence some method should be devised to preserve the fruits over a long interval of time at a place from where transport is easy and is carried out under suitable conditions.

Much of the progress in the fruit preservation industry in England is due to the researches carried out under the guidance of Food Investigation Board to which is attached the Department of Scientific and Industrial Research Leaflet No. 6 recently issued by the above Department gives complete details of winter storage of apple crop by means of "gas storage" under suitable conditions of temperature. It is now fully established that if both the atmosphere surrounding the apples and the temperature are controlled very adequate storage conditions can be provided when certain precautions are taken. Control of atmosphere enables oxygen supply to be cut down, and the carbon dioxide supply released (exhaled) by the respiration of the apples to be maintained at a suitable level. The slow respiration doubles the lifetime of the apple in store and the carbondioxide maintains the original green colour when the temperature is kept at about 40°F. By the above process of preservation, apples, pears, oranges are preserved for months and released for transport in refrigerated vans. I have described only the Board's outline of the process, there are still many minor details to be worked through before it is a complete success. For instance there is always a little amount of softening of the apples in storage, and the rate of softening depends upon the time of picking the fruit.

It will be observed that through the results of researches it has been possible to satisfy the palate and fetch more money for the same commodity. In applying these result to the cese of mangoes, guavas, granges, or apples in this country, some amount of research is necessary. Whether it is possible to preserve the fruit simply by refrigeration or by "gas storage"; there is no doubt that high temparture is a potent cause for the small life of the Indian fruits but we have to see that the fruit ripens, and then it has to be preserved. We have to find out the optimum value for the temperature, and the best supply of oxygen. All these problems have to be investigated before any definite process is evolved. The main apparatus for research is a refrigerated chamber which is very difficult to provide in any laboratory. Sir Frank Smith, Secretary to the Department of Scientific and Industrial Research, mentions that five coolers specially made to complete the equipment of the refrigerated chamber ,were presented to the Department by Messrs. J. E. Hall Ltd., Refrigerating Engineers. In this country unfortunately we have no such manufacturer of philantropic mind. Hence the whole work has to be organized by the Fruit Growers Association or local bodies if they desire to help the local industry. To complete the work the co-operation of physicist, botanist and chemist is needed. It may be mentioned here, work on the effect of carbon dioxide gas on the ripening of tomatoes and apples etc., is being carried on in Allahabad and Benares Universities.

R. N. Ghosh.

The University,
Allahabad.

Standardization of Intelligence Tests for Indian Boys

In his Report on the solution of the Unemployment Problem, the Rt. Hon'ble Sir Tej Bahadur Sapru has rightly laid a great stress on the reform of the Educational System. He believes that many who receive university education do not profit by it and only add to the congestion, and so he wants to divert a number of youths to other useful vocations before the university standard is reached. He has further advocated the use of Intelligence Tests and such other kindred devices to determine the suitability of a particular boy's profession and also his predilection for a vocation.

The suggestion is no doubt a very wise one and will surely go a long way towards relieving the congestion. But the greatest difficulty in the way would be the absence of such tests in India. There are tests and tests in England and America—some of them excellent in their own way. There are the Binet-Simon Tests for individual testing, the American Army (Alpha) Tests, the National Intelligence Tests, the Terman Group Tests, the Haggerty Group Tests and the Stanford Revision Tests in America, Burt's Tests, the Northumberland Tests of Professor Godfrey Thomson, the Columbian and Chelsea Tests of Dr. Ballard in England—all these are extremely good and very well tested. Unfortunately none of these can be adopted in to for our purposes. The language difficulty is the most obvious, but not the most insuperable, difficulty. The circumstances differ, environments are not the same, achievements of western boys and our boys at the same age are far different—these difficulties have to be taken into consideration.

What we need, therefore, is a standardized tests suitable for Indian boys. This task is not an easy one. It requires a wide field for experimentation and experienced psychologists to work out the details and to prepare a complete test. Individual psychologists may take up the work, but very probably the work will be better and more easily done if a group of scholars undertake to do it. Sufficient data have to be collected, questionanaires have to be issued, tests on a large scale have to be held and thus only a sound and reliable series may be arrived at. The Psychology Section of the Indian Science Congress or the Indian Psychological Association will do a real service to the country if they help in the task by taking the lead in the matter.

This, Sir, we believe to be very necessary and urgent. In all branches of science Indian scientists have made researches and contributions and have left their mark. Psychology is a neglected branch and India has little to boast of her contributions to it. It is time that our psychologists did something.

Bimalanda Ghosh.

Benares.
18. 6. 36.

Ultra-Violet absorption Spectra of some Paramagnetic Salts in Solution and the Nature of Chemical Linkage in them

Previous works by the author [1] on magnetic properties and absorption spectra in the visible region of paramagnetic halides of the iron group in solution or in the form of crystals, have shown that under different conditions (different temperatures and different solvents) two types of aggregates may be found, *viz.*, (i) ionic complexes where the paramagnetic ion is surrounded by a definite number of dipole molecules and (ii) undissociated paramagnetic halide molecules. The author has now studied in collaboration with Mr. M. Deb of this laboratory, the ultraviolet absorption spectra of solutions of $CrCl_3$, $CoCl_2$ and $NiCl_2$ in H_2O, et.alcohol and excess of HCl at different temperatures, using a hydrogen discharge tube as the continuous source and a quartz Fuess spectograph. It has been observed that in aqueous solutions of these salts the edge of continuous absorption is on the shorter side of 220 mμ and shift slightly towards longer wavelength side with increase of concentration. On the other hand for the same concentration of the salt and under identical conditions of experiment, when a solvent with lesser dielectric constant e.g., pure anhydrous et.alcohol is used, or when an excess of HCl is added to the aqueous solution, the edge of continuous absorption is shifted largely towards longer wavelength by several thousand wave numbers. A study of the absorption spectra of these latter solution at different temperatures again reveal that at low temperatures (−115°C) the edge of continuous absorption shifts back towards the shorter wavelength side by several thousand wavenumbers. The following table for $CoCl_2$ will indicate the behaviour of the absorption spectra of these salts under different conditions.

Substance	Solvent	Conc.	Temp.	Edge of continuous absorption.
$CoCl_2$	H_2O	IN	30°C	226 m
,,	HCl (10N)	,,	,,	280 ,,
,,	et. alcohol	,,	,,	267 ,,
,,	HCl (7 N)	.5N	+60°C	275 ,,
,,	,,	,,	−115°C	240 ,,
,,	et. alcohol	,,	+60.C	270 ,,
,,	,,	,,	−115°C	240 ,,

The absorption in the ultraviolet region for the paramagnetic chlorides in different solutions is to be ascribed to the Cl ion which under different conditions form different types of linkage with the paramagetic ion. From the observations of Franck and Scheibe[2] on the ultraviolet absorption of alkalihalide molecules in the form of vapour and in solution, it is well-known that the edge of continuous absorption in the ultraviolet region is shifted considerably to the longer wavelength side in the case of NaI vapour where I forms undissociated molecules with Na, in comparison with the same in the case of the solution where I is dissociated as negative ion. From analogy, it may be concluded that in the aqueous solutions of paramagnetic chlorides where the edge of continuous absorption is at about 220 mμ the latter must be predominantly dissociated and the absorption is mainly due to Cl ions. The shift of the absorption edge towards longer wavelength side by thousands of wave numbers in the alcohol or acid solutions, may be explained as due to formation of undissociated molecules in such cases. Similar considerations lead to the conclusion that in et. alcohol or HCl solutions though at higher temperatures the paramagnetic chlorides exist as undissociated molecules, at considerably low temperatures they dissociate into ions and consequently the absorption edge shifts back towards the shorter wavelength side.

The above conclusions regarding the nature of linkage in the paramagnetic chlorides are fully borne out by previous works carried out by the author[1] on different lines. The details will be published in the *Philosophical Magazine*.

S. Datta.

Palit Physical Laboratory,
University College of Science,
Calcutta.

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1. *Phil, Mag.*, *17*, 583, 1160, 1934; *20*, 1121, 1935.
2. *Zeit. f. Phys. Chem.*, *18*, 22, 1928.

Prafulla Chandra Rây

SCIENCE AND CULTURE

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AND CULTURAL SCIENCES
VOL. II, NO. 2.

AUGUST 1936

Sir Prafulla Chandra Ray

We offer our respectful felicitations to Sir Prafulla Chandra Ray on the occasion of his seventyfifth birthday. His has been truly a life of service and sacrifice. A life of high endeavour is always well worth relating; but in his case greatness has been combined with more than its equivalent of goodness; and no nobler example can be presented to his countrymen for their emulation.

Harish Chandra Ray, father of Sir Prafulla, was a prosperous zemindar and a man of wide culture, who early imbibed the heretical ideas of the alumni of the Hindu College, and was a pioneer in the spread of education among boys and girls in his rural district of Khulna. To his sons, Harish Chandra was a friend and companion, inculcating in them the principles of rational thinking and the lessons of dutifulness and patriotism by way of telling anecdotes from lives of great men. Prafulla Chandra joined the Hare School in 1870, but unfortunately in a few years his health was almost wrecked by an obstinate attack of dysentery and he had to leave the school. The years of physical suffering were however, in his case, years of passionate home-study; and when after convalescence he joined the Albert School he was unquestionably the ablest student there. He passed the Entrance Examination in 1879 and joined the Metropolitan Institution founded by Pandit Iswar Chandra Vidyasagar.

To the handicap of a fragile constitution was now added the equally serious one of poverty. The family estates were rapidly dwindling into insignificance due to debts incurred by his father, but this only spurred young Prafulla to greater efforts. While reading for his degree, he was secretly preparing at home for the Gilchrist Scholarship Examination. It was an all-India competition, and his success in 1882 gave him the cherished opportunity for proceeding to Europe for higher studies in science. He joined the University of Edinburgh, passed the B. Sc. Examination with physics, chemistry, and zoology, became, as he says, "passionately fond of chemistry" and obtained the D. Sc. degree in 1888 on the basis of a thesis in inorganic chemistry. He was honoured in due course by the award of a special scholarship by the Gilchrist Foundation and of the Hope Prize Scholarship, and also by election as the Vice-President of the Edinburgh University Chemical Society.

But high honours at the University, strong testimonials from professors of world-wide reputation, and powerful recommendations from well-wishers like Sir W. M. Muir and Sir Charles Bernard were of no avail at the India Office in London; and the doors of the Indian Educational Service, which was almost an exclusive preserve for Britons in those days, remained sealed to him. He returned to Calcutta in 1888, and after a year of waiting he obtained the post of an assistant professor at the Presidency College, Calcutta, on Rs. 250 a month. Persons with far inferior qualifications were holding high appointments as professors in the Indian Educational Service, and he naturally felt keenly the injustice done to him because of his race and colour. But he was determined to make the best use of his opportunities.

In Europe the reputation of a professor depends more on his capacity for extending the bounds of knowledge rather than on actual teaching work, But in India this tradition was sadly lacking. From the very beginning of his career, Dr. Prafulla Chandra Ray felt it to be his mission in life to bring this tradition of Europe into the the atmosphere of Indian universities and to create an enthusiasm for research in his young students. A stream of research work began to flow out from his laboratory, carried out either by himself or in collaboration with his senior students, and soon made him well known throughout the scientific world. These embraced a wide field of inorganic chemistry, dealing mainly with the fugitive substances called nitrites and with complex compounds of mercury, sulphur platinum, etc. Brilliant though he is as a research worker himself, he believes that his greatest achievement has been the foundation of the Indian School of Chemistry and of the Indian Chemical Society. Of him as a teacher of youth, as a *Guru* inspiring him with high ideals and the spirit of conquest in the domain of knowledge, Rabindranath thus speaks:

> "It is stated in the *Upanishads* that the One said, 'I shall be many.' The beginning of creation is a move towards self-immolation. Acharya Prafulla Chandra has become many in his students and has made his heart alive in the hearts of many. And that could not have been at all possible, had he not unreservedly made a gift of himself. This power of creation having its inception in self-sacrifice is a divine power. The glory of this power in the Acharya will never be worn out by decrepitude. It will extend further in time through the ever-growing intelligence of youthful hearts; by steady perseverance they will win new treasures of knowledge."

After 28 years' active service in the Presidency College, he retired from Government Service in 1916. The severance of connection from the College was extremely painful to him, but he found a larger sphere of work as Director of the Chemical Laboratories of the University College of Science founded by Sir Asutosh Mukerjee with the princely endowments of Sir Tarak Nath Palit and Sir Rash Behary Ghosh. For the last fifteen years, his salary is being entirely spent for improving the equipment of the laboratories and maintenance of Research fellowships.

Great as he has been as a teacher and researcher, he has also proved a most successful man of action. He has been responsible for establishing many industrial enterprises, of which the creation of the Bengal Chemical and Pharmaceutical Works is the most remarkable. When as a young D. Sc. of Edinburgh, he was trying to secure an appointment in the Education Department, the D. P. I. told him once that if he was such a clever chemist why he did not start industries and in the fulness of time keep men on the salary of a D. P. I. as his assistants. The young Professor felt that the cheap and innumerable raw materials of Bengal could be converted into costly finished products with the aid of the scientific knowledge that he commanded. Unaided, and with a capital of a few hundred rupees saved from his small salary, he began the preparation of pharmaceuticals at his own home. His duties at college were exacting; his research work in the laboratory continued every day from 10-30 A. M. to 5 P. M.; his health was much below normal; but the will to achieve success as an industrialist was unconquerable. In a few years, the house at 91, Upper Circular Road, except for the bed room which he occupied, had the appearance of a factory. His pharmaceutical preparations soon secured a well-merited recognition and the business rapidly expanded. In 1902, the Bengal Chemical and Pharmaceutical Works was converted into a limited concern with a capital of 2 lakhs of rupees, and Sir Prafulla made over his share in the concern to a trust created for conducting a High School and other beneficent activities in his native district of Khulna. Today the Bengal Chemical and Pharmaceutical Works, with his unfailing help and guidance, has a capital of over 50 lakhs of rupees, boasts of having the biggest sulphuric acid plant in Asia, and pays its manager something like Rs. 40,000 a year. The D. P. I was a prophet indeed! India is a land of wonderful incongruities. That a man of childlike simplicity—a man who abhors acquisitiveness and leads a life of ascetic self-denial—should yet be instrumental in creating the wealth of a nation is perhaps a fore-taste of the New Order which Providence has in store for us.

SIR PRAFULLA CHANDRA RAY

Students and friends of Sir Prafulla have always felt that the patriot in him has prevented the fullest realization of his genius as a researcher and an industrialist. The one passion in his life has been an ardent love for his motherland. He has reiterated from hundreds of platforms his conviction that "researches can wait, industries can wait, but Swaraj cannot wait." This passion has been the dominating force in his life. While yet a student at Edinburgh, he wrote a book on *India before and after the Mutiny* and drew pointed attention to the disabilities and grievances of Indians under British rule. His *History of Hindu Chemistry* in two volumes was the result of a long and painful research extending over a period of about ten years. It has earned for its author a great reputation and has been acclaimed as adding a very interesting chapter to the history of sciences and of the human spirit. In this self-imposed task, Sir Prafulla was guided by the hope that a rediscovery of the past might bring confidence in the future. Time and again, we find the scientist laying aside his test-tube and leading great movements for the relief of the distressed and preaching new ideas for the moral and material progress of his countrymen. A man of wide culture, interested in almost all activities of human life, he has come to occupy a unique position in the political and educational world of Bengal. Living a life of severe asceticism, spending whatever he has for the benefit of the poor and the oppressed with instinctive shrewdness and an unusual degree of commonsense, he has always justified the enormous confidence which his countrymen place in him. His work in connection with the North Bengal Flood of 1922, whose havoc is yet fresh in the memory of many, has thus been described by the special correspondent of the *Manchester Guardian* :

> "In these circumstances, a professor of chemistry, Sir P. C. Ray, stepped forward and called upon his countrymen to make good the Government's omission. His call was answered with enthusiasm. The public of Bengal in one month gave three lakhs of rupees ; rich women giving their silk and ornaments and the poor giving their spare garments. Hundreds of young men volunteered to go down and carry out the distribution of relief to the villagers, a a task which involved a considerable amount of hard work and bodily discomfort in a malarious country."

The enthusiasm of the response to Sir P. C. Ray's appeal was due partly to the Bengali's natural desire to score off the foreign Government, partly to genuine sympathy with the sufferers, but very largely to Sir P. C. Ray's remarkable personality and position. He is a real organizer and a real teacher. I heard a European saying :

> "If Mr. Gandhi had been able to create two more Sir P. C. Rays, he would have succeeded in getting swaraj within this year.... He is too warm-blooded and energetic a man to make a perfectly fair critic (of Government). But any man who feels aggrieved by his criticism has at least the satisfaction of knowing that unlike so many critics Sir P. C. Ray would never shirk taking on the job himself, if the chances were offered him, and if he did take on the job, he would like to put it through about as well as and perhaps a little better than anybody else."

Honours have come thick on him, but none he prizes more than the endearing epithet of "Acharyya" which his countrymen have always associated with his name. Two years ago, he was elected an Honorary Fellow of the Chemical Society of London. Sir Gowland Hopkins, Ex-President of the Royal Society, and Prof. C. Matignon, Member of the Institute of France, were the other two recipients of the honour on that occasion. This appreciation of his services by his fellow chemists of the British Empire has touched him deeply.

We may well conclude this short sketch with the eloquent tribute of Prof. Debaprasad Ghosh—

> "It is the radiance of love and selfless devotion that has invested Acharya Ray the student, the savant, and the man of action with a halo ineffable. It may indeed be said of him that in him have blended *Jnana, Karma, and Prema*—the triple fruition of a harmonious life. May this blessed life be spared for a long time yet to serve at once as a beacon light and a comfort to his admiring and adoring countrymen !"

Earth Leakage Protection on Consumers' Premises

T. C. Gilbert
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EVEN more important than the matters discussed in my last article is the provision of adequate earth leakage protection on the consumer's installation. The insurmountable difficulties associated with the efficient application of solid earthing in rural areas has already been dealt with, and in any case is too well known to require emphasis. Conditions are very little bettered with the multiple earthing of the neutral line on the consumer's premises, as such earth connections, to be effective, must necessarily be of low resistance and heavy current carrying capacity, two requirements impossible to achieve in practice.

The experiences of such countries as New Zealand, America, Canada, and several of the countries of the continent of Europe, all of which have employed multiple earthed neutrals for many years and are now considering the use of the much more efficient method that I shall discuss, lead us to believe that consumers' safety cannot be secured by multiple earthing. This is especially the case with Germany, where multiple earthing is especially universal ; it has been abandoned as a form of leakage protection in rural areas, and even in some towns, where earthing conditions may be considered good. The most convincing case is that of Berlin, where practically the whole of the supply is in the hands of Bewag, a private commercial concern, and over 25,000 cookers are connected to their mains. *Every one* of these is protected against leakage troubles by means of an earth leakage trip, of the exact pattern that I shall describe, as this is considered to be the only practical and effective means of affording such protection. Not one accident in connection with cookers, or any other apparatus protected by the same means, has ever been reported, and this must be without parallel in any other part of the world,

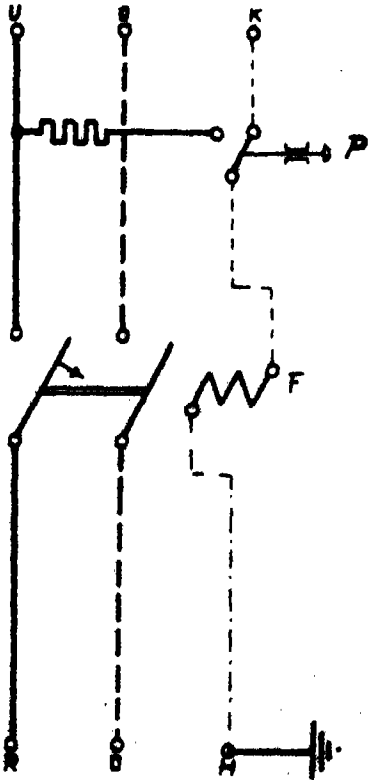

Figure 1.

The use of such leakage trips is now compulsory through practically every rural area in Germany, and as stated in my first article, there are over 80% farms connected to supply mains operating at 380/220 volts, 50 cycle a. c. There is a similarity between conditions in the German rural areas and in India, as the labourers in the former usually work bare-footed, which fact has led to numberless accidents from shock in the days of the more usual protective measures. Leakage trips have been installed for the past ten years, however, with a marked improvement ; the extension of the system to the towns and cities, as instanced in the case of Berlin, is sufficient endorsement as to the complete efficacy of the system, and there is no need to take up further space in quoting further experiences in this country.

The ordinary form of leakage trip is a very simple device, and is shewn in Figure 1. This is of double-pole pattern, the trip coil being at F; P is a test key, which when depressed makes contact between the earth electrode and the phase line through the high-resistance shewn, and thus places an artificial earth leakage through the device. If all is in order, the switch operates, and it will be noted that the earth terminal of connected apparatus is disconnected, terminal K, when this test is made.

The trip coil responds to a leakage current of about 30 milliamperes; the earth electrode may be of very simple construction, usually a driven spike or tube, and resistances up to seven or eight hundred ohms do not vitiate the protection afforded. British regulations are content to demand an "earth leakage trip operating at not more than 30 milliamperes", (1005 C.) in all cases where earthing resistances exceed one ohm; the German requirements are more explicit, however, and provide (v. D. E.). "With a resistance of 200 ohms in the earth circuit the switch shall trip with a potential of 22 volts, plus or minus 2 volts, and with a resistance of 800 ohms in the earth circuit the switch must trip with a potential of less than 65 volts." This resistance is, of course, over and above any impedance due to the trip coil itself, and corresponds to the actual resistance of the earthing electrode. The impedance of the trip coil varies with different makers, but is usually between 500 and 600 ohms at 50 cycles.

The limitation of leakage *potential*, as opposed to the comparatively unimportant leakage *current*, exemplified in the comparison between the British and German requirements, is of course the condition to be aimed at, and there is little doubt that the British regulation will be amended along these lines. The error in drafting is unfortunate, and was probably due to incomplete comprehension of the principle involved in the newer method. One dares to say such things in a Colonial paper, however hesitant at home, but general opinion will secure the necessary amendment; leakage trips are not yet common in this country and at the time when the regulation was drafted were comparatively unknown.

It will be immediately obvious that the use of this device eliminates the menace of the inadequate earth, and, further, that its application is universal. Leakage protection can be applied at any point required, whether at the main position covering the whole installation, at sub-circuit positions, or to individual apparatus. No form of overload protection is incorporated, this being effected by the usual means of fuses or circuit breakers, although leakage trips are obtainable incorporating overload trips in addition. It is often found, however, that individual apparatus may require leakage protection in vulnerable situations, the necessary overload protection being confined to groups of such apparatus. A little reflection will indicate that there is really no relation between the twin problems of overload and leakage protection, and they should be considered separately; they have only become associated by reason of the fact that one device, the overload, has had to do duty for the two entirely different types of fault.

Leakage trips may also be utilized on systems of supply without earthed neutral—that is, a three-phase system without any connection of the neutral to earth at any point—there always being sufficient distributed leakages or capacitance to operate the trip, and also with systems with the neutral earthed on the consumer's premises. It might be thought that a multiple earthing connection to the neutral line would effectively short-circuit the leakage trip, but this is not the case. Reference back to the sub-station switch will shew that it is possible to have the two earth connections in parallel; the earth leakage trip becomes truly supplementary in such case, coming into operation only with the appearance of a potential upon the casing of the protected apparatus, indicating failure or ineffectiveness of the main earth connection. The practice in Germany is to multiple earth the neutral line, instal fuses on the phase line only, and connect the leakage trip coil between the third pin of plugs or the earth terminal of apparatus or switchgear and the earth electrode. In such cases the supplementary earth from the leakage trip is placed as far from any sphere of influence of the main earth electrode as possible, but it will be agreed, I think, that in the presence of this very effective form of earth leakage protection the multiple earthing of the neutral line is superfluous. In this country, multiple earthing is not practised, there being one neutral earth connection only, at the generating or substation but the Dumfries Electricity Department has utilized a single-pole leakage trip throughout its area; double-pole protection is to be preferred, as the neutral line may be a very live line in rural areas, under some conditions.

In addition to providing adequate leakage protection in the face of high earthing resistance, the system incorporates complete ease of test of the protective circuit, of almost equal value. In most modern trips a test key is provided, which when pressed (see Fig. 1) connects the phase to the trip coil, corresponding to an artificial leakage. At the same time the earth circuit to connected apparatus is disconnected in order to prevent the extension of this test potential in unwanted directions, and the operation of the trip indicates that the earth circuit is intact and the mechanism responsive. Even more valuable is the fact that the test can be made from the actual apparatus right down to the earth electrode, by the simple expedient of short-circuiting the phase terminal to the earthed frame, and the small leakage current involved ensures that fuses will not be blown nor overload devices operated.

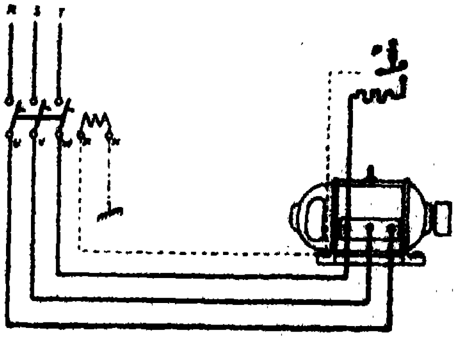

Figure 2.

Test key extended to become the stop button of motor controller, giving constant test of the protective circuit.

No resistance need be inserted, although common practice on the Continent is to use a small test lamp between phase and earth terminals, and by this means the flexible connections, the plugs and sockets, the trip and the earth electrode may be completely checked in a few seconds. It is even possible to pass the requisite leakage current through the human body without danger, the speed of disconnection, about 1½-2 periods of the supply alternations, preventing risk although providing considerable discomfort. This ensures that apparatus with exposed or incompletely guarded elements may be safely earthed by this means.

In some German apparatus and installations, this test of the protective circuit is made automatic; a case is shewn in Figure 2 where the extension of the test key is made the normal stop button of a motor controller, ensuring constant test of the earth connections. Many similar arrangements are made, and in one form of domestic switch-socket, incorporating leakage trip protection, the normal operation of the controlling switch provides the test; a similar arrangement is made in the case of a heavier socket for farm apparatus, and great importance is attached to this feature.

It is recommended that where this apparatus is installed that reliance be not placed upon the continuity of conduits or lead sheathings—so often a delusion and a snare—but that a small lightly-insulated earth conductor be employed, such as an ordinary bell wire, or similar. For farm work a tough rubber wiring system with a small earth conductor placed under the outer rubber sheathing is ideal, and as this conductor will only ever have to deal with earth currents amounting to about 30 milliamperes, whatever the size or capacity of the connected apparatus, it may be as small as mechanical considerations permit. Earth connections to electrodes should be corrosion proof, and made in some lightly protected cable such as P. R. J., which has the further advantage of being distinctive. On the Continent, leakage trips are installed with a form of lead covered cable, with a small earth conductor below the lead sheath—similar to Henley's "Bondit" system—and with paper conduits and separate earth wire.

In all cases where earth leakage trips are employed, the earth electrodes may be of the simplest possible types, usually consisting of spikes of pipes driven to a depth of four to six feet; no advantages appear to accrue from using longer pipes, except in particularly difficult situations. Earthing resistances of about 1,000 ohms do not prevent isolation, or even up to 4,000 ohms, but it is clear that the lower the earth resistance the lower the leakage potential before isolation.

This fact may offset a criticism sometimes heard, that the use of leakage trips may introduce an expense into rural electrification that it cannot well bear. The cost of a leakage trip can in all cases be recovered by economy in the construction of earth electrodes, as will be clear from the foregoing, and in addition, earthing protection becomes really effective and not the purely problematical matter usually associated with costly earths and solid earthing. Further, leakage trips are not expensive, as will be seen from the example illustrated here consisting of a double-pole device, complete with test key, of 30 amperes capacity, hand-operated, and costing something between 12/- and 14/- each, according to quantities.

This device is made by a wellknown switchgear maker and complies with the German requirements as well as with the British regulation; made in London, its distribution through the Colonies will probably be in the hands of Messrs Siemens, to whom application should be made for samples and prices. From my own tests, it is a device that can be thoroughly recommended, and is the first British apparatus to be produced at a reasonable cost; smaller and larger models are following, and very shortly the complete range will be available.

It will be seen that for about 14/- earthing security can be ensured, and the whole earthing system, with electrode and leads, will cost under a sovereign. I have never yet seen a measure of security with solid earthing achieved for even ten times this sum, and even then the periodical testing of this expensive electrode—unnecessary with leakage trips—involved considerable expense.

An interior view of the device described is shewn in Figure 3, and an exterior view in Figure 4. The cover is of moulded insulating material, with the test key press at the bottom left. The prospective user of leakage trips is warned against accepting devices with metallic covers, for reasons that will be obvious—one being that with the pressing of the test key the metal case is isolated from earth—and care must be taken to select a device that does not employ very fine wire windings for the trip coil.

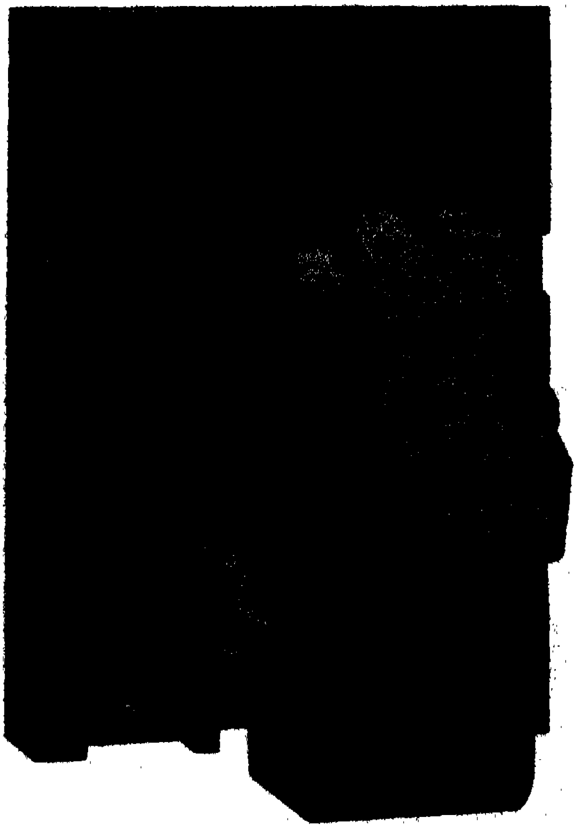

Figure 3.

Double-pole 30-ampere earth leakage switch.
(Nalder Bros. & Thompson Ltd.)

The device in question has its coil wound with 28 or 30 s. w. g., but there are many devices on the market using 40 or 42 s. w. g. The reasons for this will be dealt with later.

That further economies are possible in the rural area with the use of leakage trips will be clear from Figure 5, in which the continuous earth conductor, whether provided by conduit or other means, is eliminated, and all earth connections are made locally through leakage trips. Apart from the economical aspect, continuity of service is ensured in that only the device or circuit actually affected by leakage is isolated; such an arrangement is not possible under solid earthing conditions, but perfectly satisfactory as shewn. The low cost of the individual trips has already been emphasized, and no engineer with rural experience can fail to recognize the obvious advantages of this arrangement. The hand-operated device becomes also the circuit switch, and all apparatus may be controlled by the leakage trip.

By this arrangement another trouble associated with solid earthing in rural areas is overcome, that of the extension of leakage potentials from a faulty device that cannot be isolated by reason of heavy earth resistance to all other sound apparatus connected to the same earth circuit. Potential gradients on the earth's surface become a thing of the past, as the low leakage currents employed cannot possibly set up such conditions even against excessively high earthing resistances. One of the devices described is working in my own grounds using a three-inch nail as an electrode; the resistance varies between 1,200 and 5,000 ohms, according to weather, but the switch operates with about 80 volts. A ring of test electrodes round this nail have indicated a potential of 6 volts on one occasion, but usually the readings are zero; with an ordinary two-foot electrode, gradient readings are unobtainable.

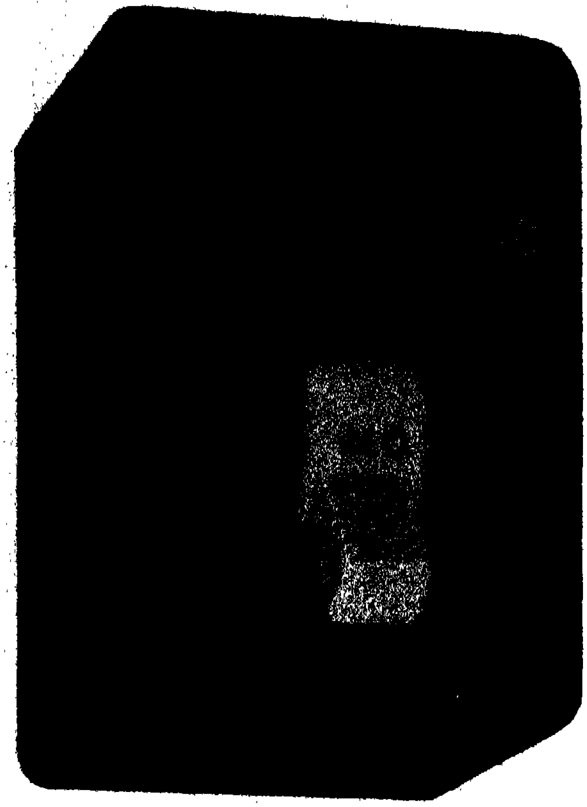

Figure 4.

Exterior view, 30-ampere double-pole earth leakage switch.

(Nalder Bros. & Thompson Ltd.)

It is difficult to include all the advantages of the form of protection in anything less than a book, and practical experience is necessary to fully appreciate them. With the utilization of effective leakage protection the fire menace to rural installations is reduced. It is admitted that this risk is small in the British Isles, but in other countries subject to lightning disturbances it is a factor to be taken into account. We have it upon the authority of Inspector Germiquet, of the Fire Insurance Society of the Canton of Berne, Switzerland, that the fire risk from lightning has been considerably reduced in installations equipped with leakage trips, and this point appears worthy of emphasis. It is apparently established that in systems employing solid earthing a lightning flash or induced secondary in passing from the building wiring—being brought in by the overhead line—to the earth conductor, is followed by the line current, setting up a serious fire risk. The comparatively high impedance of the leakage trip coil, however, provides a sufficient bar to the line current and prevents an arc continuing from the lines to the earth circuit, but the trip coil must be of stout construction, without fine windings.

I would strongly urge all engineers faced with earthing difficulties to take little or no note of this article, but obtain for themselves a range of the necessary equipment and carry out their own tests under practical conditions, when I am sure that many of their problems will be solved, if not all. By the time these lines are read the full range of British-made equipment should be available, but we in this country have had to carry out our preliminary work and equip our trial installations with German apparatus. This, good as it is, does not exactly meet our requirements in many details.

Although I have concentrated upon the rural installation in these notes, yet it will be obvious that the system of protection described can be extended to installations of every kind, even where earthing conditions are good. Leakage trips have advantages in such installations, for, briefly, the limitation of leakage currents permits the earthing of delicate apparatus that would otherwise be completely broken down at the first serious fault with solid earthing ; earth leakages can be detected and rectified whilst incipient and before they become complete and expensive ; whilst protection is independent of the circuit. Gas pipes, hot-water systems, and steel frame-works of buildings now become adequate earth electrodes with this system, facilitating the protection of the individual device as opposed to group protection. There is now no need to run earth wires back to rising water mains, and many of the Berlin cookers mentioned in the beginning of this article are earthed to gas pipes.

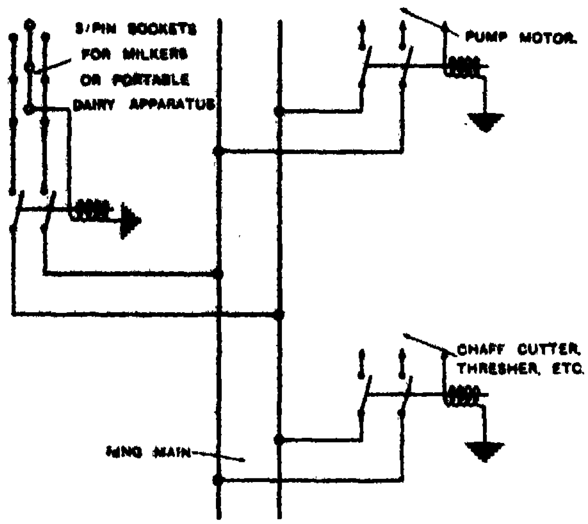
3/PIN SOCKETS FOR MILKERS OR PORTABLE DAIRY APPARATUS
PUMP MOTOR.
CHAFF CUTTER, THRESHER, ETC.
RING MAIN

Figure 5.

Sub-division of earth leakage devices. Local earth connections at each individual machine.

In the conduit or lead-sheathed installation no amount of false earths, that is, accidental contacts with earth from conduits or sheathings, conduits in contact with steel frames or water pipes, can vitiate protection, as will be clear if the principle of the substation switch is grasped. The leakage trip will not function until a predetermined leakage *potential* appears upon the protected casings or conduits, such potential being only dependent upon the resistance of the supplementary earth ; if the false or accidental earth contacts prevent the appearance of this potential, then no danger arises and there is no call for the operation of the device.

Space will not permit an examination of the various practical arrangements adopted abroad for the effective protection of main circuits, sub-circuits and final sub-circuits or individual appliances, and I should like to recommend those in search of further information to my book on the subject,* which has already appeared in India. There is little doubt that the system will shortly be in increasing use in this country, and as it appears to have especial value in a country like India I hope that engineers in that country will lose no time in establishing its claim to the fullest possible consideration there.

I believe that the engineer in charge of the Cawnpore Electricity Supply authority, Mr. Meares, is already in possession of some apparatus and is conducting tests, and no doubt further information will be available from that quarter.

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* ***Artificial Earthing for Electrical Installations*** Messrs Ernest Benn, Fleet Street, London. 9/-

The National Physical Laboratory

Report for 1935

Introductory

THE National Physical Laboratory, which was founded at Teddington in 1900, is now a large institution occupying 15 large buildings in grounds of some 50 acres, and with a staff exceeding 600. The Laboratory also possesses a large radio Research Station at Slough, a smaller radio station at Leuchars in Scotland, and a station at Lambeth in which all the taximeters of the taxi-cabs in London are tested annually. The Laboratory is devoted to research and test work in the various branches of physics and engineering, as heat and refrigeration, sound, optics, radiology, electricity and magnetism, radio, fine measurements, mechanical engineering, metallurgy, aerodynamics, and ship design. It is responsible for, or assists in, the maintenance of the majority of the official physical standards of the country, *e. g.*, length, mass, temperature, candle-power, and the electrical standards. The Laboratory is a Government Institution under the Department of Scientific and Industrial Research.

Since its foundation the Laboratory has been an essential factor in the development of British Industry. To mention but a few examples of this, the high accuracy now attained in mass production in this country is largely founded upon the Laboratory's work on the standardization and testing of engineers' gauges. The accuracy of measurement of electrical power throughout the country is ultimately dependent on the electrical standards—the ohm, volt, and ampere—maintained at Teddington with an accuracy of one or two parts in 100,000. It may be said that the scientific basis of the light alloys industry of the country—so important in aircraft construction—largely depends on the work of the Metallurgy Department on the alloys of aluminium. The Aerodynamics Department has carried out work, *e. g.*, on spinning, stability and control, and flutter, which has done much to increase the safety of flight during the past twenty years, and the research work crrried out in the ship tanks of the William Froude Laboratory has effected an increase in ship efficiency of some 20%.

The William Froude Laboratory

In 1934 the Report recorded a record number of ship designs tested at the Laboratory, namely 60. This record has been considerably exceeded in 1935, and during the year no less than 73 ships have been tested, involving the making of 160 ship models. Effective improvements have been made in 64 of these ships as a result of the tests. In thirteen cases the improvement represents more than 10% on the fuel consumption, and in four cases more than 20%. The ship models are tested with model propellers driven by a small electric motor in the hull. Service results on actual ships previously tested in model form have completely established the fact that recent advances in ship design originated at the Laboratory exert their full effect on the ship at sea.

Research work on small craft was begun in 1934, and this has already resulted in a reduction of 30% in the power required to propel a series of ferry steamers.

Aerodynamics Department

Effect of Surface Roughness on Aeroplane Wings (*Report p. 173*).—Recent tests in the Compressed Air Tunnel at the Laboratory have proved that the speed of aeroplanes can be considerably increased by ensuring that the surface of the wings, etc., is as smooth as possible. Roughness increases the wind resistance, and thus lowers the speed to an unexpected degree. A roughness corresponding to grains four-thousandths of an inch in size can produce an increase of some 30% in the resistance of the wing of a modern aeroplane travelling at 200 to 800 miles per hour, while even grains of one-thousandth of an inch can produce an appreciable effect. The importance of smooth surfaces is thus fully demonstrated. The effect of small well-rounded excrescences, such as rivet heads, is not so serious as that of a fine distributed roughness like that of a badly-finished surface, but nevertheless it also seems worth while avoiding projecting rivets on the fastest aircraft.

Research on Air Flow (*Report p.* 178).—Many of the problems that puzzle the aeronautical engineer would have been immediately clear if it were possible to *see* the air flowing over surfaces such as the wings of an aeroplane. Many attempts have been made in aeronautical laboratories to see and photograph air-flow by the use of smoke, and such work has helped enormously in understanding the nature of aerodynamic phenomena. A method has recently been developed at the Laboratory by which much finer detail in the air-flow can be observed than was possible with a diffuse smoke. It consists of the photography of the shadows of small spots of hot air moving with the current. The hot air spots are produced at suitable places by tiny electric sparks. By using slow motion cinematography, the movements, which are too rapid to be followed by the eye, can be slowed down to a speed at which every detail of the motion can be clearly seen. It is even possible to measure the speeds of the hot air spots from the film and to obtain numerical values of the air-speeds at different positions in relation to an aeroplane wing. The films that have been obtained show very clearly the nature of such phenomena as the stalling of wings, the effect of wing slots, and the reduction of resistance by good streamlining, and the results should have an important effect on aircraft design.

Physics Department

Safety of Workers with X-Rays and Radium (*Report pp. 40, 41*).—On 4th April, 1936, a memorial was erected at Hamburg to 160 scientists, nurses, etc., whose death was due to working with X-rays in the early years after their discovery. To-day in spite of the fact that almost every hospital has its X-ray plant and supply of radium, injury to workers and patients is practically unknown, and this is in great degree due to the pioneer work carried out at the National Physical Laboratory on X-ray and radium protection. On this work was largely based the International Recommendations for X-ray and Radium Protection, which are in general use throughout the world.

X-ray and radium technique is being continuously improved : X-ray generators of ever-increasing power are being used and radium is being employed in greater quantities. As a result new problems of protection and dosage frequently arise and are investigated by the Laboratory. For example, further work has been carried out during the past year on the absorption of the radiation from radium by such building materials as brick walls and breeze blocks, and the results have direct application in the design of radium departments for hospitals.

Buildings and Noise Problem (Report p. 50).—The Laboratory has devoted much time to the study of the noise problem in buildings during the past year, both walls and floors having received attention. In modern flats the question of the floor is perhaps the more important, since sounds caused by direct impact to the structure are transmitted much more readily than those which have to pass through the air before reaching the structure. Even in the case of musical instruments playing in an adjacent room, it is the sound transmitted directly through the legs of the instrument to the floor which causes serious inconvenience. The value of a "floating" floor (*i. e.* a subsidiary floor resting on, and insulated from, the structural floor) has been recognized for some time, and the recent work of the Laboratory has been in the direction of improving the design of such floors. A design of floating floor resting at intervals on small rubber pads has been evolved, which possesses enhanced insulating properties. It has been found that the dimensions of the rubber pads are important, both in affecting the intensity and the quality of the transmitted sound. As a result of this work it appears not too much to hope that a floor and ceiling combination can be designed which will eliminate inconvenience from noise from the flat above, at a cost which will enable builders to employ it in flats of low rental.

Electricity Department

Electrical Standards (*Report pp. 57-69*).—The Electrical Standards Division is responsible for the maintenance of the ultimate standards of electrical current, resistance, and voltage of the country, in which work an accuracy of 2 or 3 parts in 100,000 is achieved. This high accuracy is seen to be necessary when it is realized that all British electrical measurements are ultimately dependent upon these standards, and that a small error in the standards would affect the charges for electricity supplies valued at many millions of pounds. The work in part takes the form of frequent co-operative work with the national standardizing laboratories of France, Germany, the United States of America, and other countries.

This Division is also responsible for the standards of radio-frequency. The character of this work is such that a very high order of accuracy is attainable, and a recent comparison made simultaneously on a standard broadcast wave by this Laboratory and several continental laboratories gave agreement to one part in ten million.

Electrical Barrage for Eel Fishery (*Report p. 73*).—At the request of the Government of Northern Ireland, experiments have been carried out on the practicability of installing an electric barrage in connection with an important eel fishery. The object is to guide the eels into the part of the river where the traps are installed, by electrifying the water where it is desired to prevent them from passing. Experiments with eels have been made in a wooden tank at the Laboratory with promising results, and these have been extended to more natural surroundings at the Fisheries Experimental Station, Alresford, Hants. Quite a low voltage is sufficient to act as a barrage, and on account of the high resistance of river water the power required is small. The Irish eel fishery is seasonal, and it is hoped that full-scale experiments in the eel fisheries of an Irish river will be carried out in 1936.

Street Lighting (*Report p. 84*).—During the past two years the new type of discharge tube has been increasingly employed for street lighting. These are of two types, *viz.*. lamps giving a green light, which are mainly used in this country, and those giving a yellow light, which are used more generally abroad. This raises the question of whether some particular colour is more effective than ordinary white light in promoting visibility on the roadway, and this subject is being studied by an interesting method in the Photometry Division. This consists of projecting on to a screen a cinematograph picture of a lighted street in which objects appear from time to time at different points, and these objects must be detected and reported by uninstructed observers. By using lamps giving different colours in the projector it is hoped to detect any difference in the revealing powers of street lighting installations employing these lamps.

Radio Department

Atmospherics (*Report p. 107*).—Atmospherics are a serious hindrance to radio communication, but they may be a help to meteorology. For both reasons it is desirable to know what they are and where they come from. To get an answer to the second of these questions, the Radio Department is using a technique similar in principle to sound ranging, *i. e.*, simultaneous observation of the direction of arrival from the two ends of a very long base line. The baseline used for the investigation of atmospherics is about 300 miles long, one end being at Slough in Buckinghamshire and the other at Leuchars in Fifeshire. Synchronized automatic drum-recording at each station has been developed in a way which makes it possible to record the results of thirty minutes observation at ten yards a second (*i. e.* 12 miles of track) on a single sheet of paper about one yard long and four inches wide. These methods are being used to record the wave-form, intensity (or strength), and direction of arrival of all the atmospherics occurring in selected intervals of time.

Radio as an Aid to Aviation (*Report pp. 101-107*).—The continued development of civil aviation requires continued improvement in what is known as "ground organization", an important element of which is the provision of means for locating and guiding aeroplanes flying in darkness or in fog. This has given an added importance to the question of improving methods of locating the position of an aeroplane by determining the direction of arrival of signals from radio beacons whose situation is known. The Laboratory is studying this problem on behalf of the Air Ministry, with particular attention to the elimination of the errors in the apparent direction of a transmitter arising from the effects of waves reflected from the upper atmosphere. The valuable possibilities offered by the now familiar cathode-ray tube have been applied to the problem resulting in the design of apparatus whereby the apparent direction of arrival of a radio transmission is shown visually as a bright line on a circular screen. Shorter waves are also being tried for this work, those in the range 30-70 metres, for example.

Another item arising directly from the requirements of civil aviation is the study of the so-called "marker beacon"—a special type of transmitter whose function is to indicate to an aeroplane when it is flying immediately over a given point or line on the ground.

Metallurgy Department

Research on Dental Fillings (Report p. 167).—The recent research work of the Metallurgy Department on dental alloys has proved valuable in enabling the practising dentist, by following a regular routine, to make the fillings of teeth more permanent. The amalgam used by dentists for filling cavities in teeth is made by mixing fillings of an alloy with mercury. The alloy is composed essentially of silver and tin, but smaller quantities of other metals may be added, and many different compositions are actually in use. The mixture with mercury, called an amalgam, remains pasty for a time, but gradually hardens. It must reach a certain strength, take a high polish, remain uncorroded in the mouth, and have other properties, of which the most important is the constancy of volume. A properly made amalgam expands very slightly during setting, to fill the cavity tightly, but afterwards its volume should remain constant. The research work carried out at the Laboratory has shown that the composition of the alloys used must vary only within narrow limits. A little too much tin causes too much expansion, whilst too little tin causes contraction so that the filling becomes loose in the mouth. Further, it has been shown that the time of mixing the fillings with the mercury and the pressure used in mixing affect the result, so that a uniform procedure should be used.

Engineering Department

Fatigue of Metals under service Conditions (Report p. 139).—An important problem confronting the designers of automobile and aeronautical engines, is to know how the various materials of construction, such as steels, will behave under the complicated system of forces imposed upon them in service. In an engine crankshaft, the forces resulting from the explosions in the cylinders tend to make the crankshaft bend, while the effort required to drive the car or aeroplane forward results in the crankshaft being twisted. The bending and twisting forces act at the same time, in varying proportions. Under service conditions these forces are applied hundreds or even thousands of times a minute while the engine is running. Further, the surfaces of a crankshaft cannot be left perfectly smooth; oil holes must be drilled to permit lubrication, corners are necessary where the crank-pin merges into the crank-arm, and keyways have to be cut for the attachment of gears and propellers. All these cause concentrations of stress and thus weaken the shaft.

To assist the engineer in calculating the required sizes of components to withstand these combined and concentrated stresses, a research is being carried out in the Engineering Department. Special machines have been designed and constructed in which test-pieces of the various materials are subjected to similar conditions of stressing as components in service. Bending and twisting stresses are applied simultaneously in varying ratios, and the effects of oil-holes, etc., can also be investigated. From this work general laws have already been established which the engineer can apply in the design of engine crankshafts and other components subjected to combined fatigue stresses.

X-Ray reveals the manner in which Metals Break (Report p. 138).—In view of the use of metals in every form of engineering construction, and of the serious consequences which may arise when metal parts break, it is desirable to know exactly what happens when fracture occurs. A research on this question which has just been completed at the Laboratory has afforded much new and interesting information. Each individual crystal in a piece of steel—there are from one million to one hundred million such crystals in every cubic inch of the metal—is built up of a regular arrangement of atoms. As the conditions of fracture must be associated with this crystalline structure, which is invisible to the human eye, X-ray methods have been used to study the changes which lead to fracture : the X-rays are capable of revealing these submicroscopic changes. A large number of steel specimens have been deformed and fractured under a wide variety of applied forces. In some cases, the forces were sufficiently great to break the metal at one application, in others, they had to be applied millions of times before fracture occurred, while in a third series, the forces were only sufficient to change the shape of the specimen, without fracture, even after many millions of applications. The work has shown that, whatever the type of applied stressing, fracture occurs when a definite limiting condition of the crystal structure is reached. The changes leading to this condition can be described briefly in non-technical language as follows :—

Consider an individual crystal, of size less than one-hundredth of an inch. Before any force is applied the atoms are arranged in parallel planes throughout its volume. When the stress is applied the crystal begins to break up into two distinct types of fragment. It breaks roughly into two halves, and in addition a number of very tiny fragments are formed of uniform size, measuring about one hundred-thousandth of an inch in length. With further deformation the larger fragments again break into halves, with the formation of more of the tiny fragments. The process continues until the crystal is entirely "shattered" into a mass of the tiny fragments, inclined to each other at every conceivable angle. A new fact is then observed : these fragments are severely strained, neighbouring atoms in each fragment being either nearer to or more remote from each other when compared to their original relative positions. Finally, when the crystal is entirely fragmented and the strain in the tiny fragments has reached a limiting value, the metal cracks or breaks.

On the practical side, the results are very important. It is shown for the first time that the fracture of engineering components occurring under a great number of methods of straining results in the attainment of one and the same physical state of the crystalline structure. The connecting rod of an engine may run for many years and then, without warning, fall into two parts ; or a crane chain may be grossly overloaded and suddenly snap. The first failure—to which the term "fatigue" is applied—may have taken years of time and millions of engine revolutions to produce ; the second failure may have been caused in a few seconds. But we now know that in both cases the fracture marked the attainment of the same condition in a number of crystals, *viz.*, the curious state of disintegration described above, at which the material could no longer retain its cohesive properties.

People and Castes of Bengal

(Continued from the last issue)

Bhupendra Nath Dutta

FINALLY it is to be emphasized here that people confuse race with language in the case of the Vedic tribes. The problem of the people who spoke the original Indo-European language and the problem of the racial origin of the Vedic tribes who called themselves as *Aryas* are two different things. The problem of the original Indo-European being either Central-European 'wiros' or German 'Nordic' or Hindukush 'Alpine (Armenoid) or South-west Siberian' 'Proto-Nordic' is extraneous to the question of the racial identity of the Vedic people. The Indo-European-speaking peoples are nowadays to be found amongst the so-called Nordic, Alpine, and Mediterranean races.

Leaving the eternal riddle of the Indo-European question as the matter of intellectual gymnastics with the national and racial chauvinists, we apply ourselves to the present-day anthropology of India. Regarding the present-day Indian castes, by referring to a biometric analysis[1] made by the writer of this paper, of the data of some of the castes from the Punjab to Bengal furnished by Risley, it is to be found that if in the Punjab the Jat-Sikhs have dolichoid-leptorrhin element in majority, the Khatris have the dolichoid-mesorrhin element in majority. Again, brachycephal-mesorrhiny exists in a very small percentage with the Khatris and the Churas, while dolichoid-chamoerrhin element is to be found with these castes in a small percentage. Again, with the exception of the Jat-Sikhs, dolichoid-mesorrhin element is preponderant with the various castes of the Punjab, U. P., Behar and Bengal; while the brachycephal-mesorrhin element is to be found in a very small percentage with the Brahman, Chhatri, Bania, Kayastha, Goala, and Kurmi of the U. P. Of these castes, the Chhatris show the largest percentage of the same element in them. As regards dolichoid-chamoerrhiny, all the castes analysed show the percentage in various proportions ranging from 11 to 37. As regards Behar, we find the phenomenon of brachycephaly increasing from this part of North India and reaching its maximum in Bengal. But dolichoid-chamoerrhiny is found in greater percentage with the Musahars of Behår, a so-called untouchable caste, than with the Bagdis of Bengal who are of the same social status. Finally, coming to Bengal the analysis shows that the Kayasthas show more of brachycephal-leptorrhiny in them than the Brahmans, while reverse is the case in the matter of dolichoid-leptorrhiny. Again, the Kaibartas show the largest percentage of brachycephal-mesorrhiny in them.

In this analysis we find that the same kinds of racial elements are to be found all over North India. Here, we must say that Risley's old theories regarding the racial analysis of India is no longer regarded as tenable. Finally, coming to the latest Ethnographical Report of the *Census of India*[1] we find that as regards inter-relations of racial likeness between the peoples of different provinces it says "the closest relationship of the N. W. Himalayan region is with U.P. followed closely by Bengal and Central India... Taken as a whole there does not appear to be much relationship between Bengal and Tamil Nadu and Central India... Affinities are also shown by the Nair of Malabar and the Pathan of N. W. India with the Bengali Brahman and by the Nagar Brahman, the Tadjik, the Kathi and the Bania Jain with the Bengali Kayastha....... The Pods (an untouchable depressed or agricultural caste of Bengal), however, show much wider relationships being connected with the Oriya, Malve Brahmans, the Rajputs, the Audich Chitpavan and Desastha Brahman, the Maratha, the Illuva and Kanada and Telegu Brahman. On the other hand, no relationship is shown with the Khasi of Assam, either collectively or individually as indicated by the high values of the C. R. L. This should dispose off finally the hypothesis of the Mongolian origin of the Bengali people[1]".

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[1] B. N. Datta—"Das Indische Kasten System" in *Anthropos* Bd XXII, 1927.

[1] B. S. Guha—*Census of India*, 1931, Vol. I, India Pt. III. Ethnographical P. XIX.

This is the latest opinion of the Government Ethnographical Report. All these clearly demonstrate that the people of Bengal racially are not different from the rest of Aryavarta. Those who following the theory of Risley have led themselves to believe that the people of Bengal are different from the rest of North India, and that her people have been taken to Brahmanical polity after the performance of the *Vrotya-stoma* need change their opinion in the matter of anthropology of Bengal. Rather, these somatological reports show that Bengal has got the same racial elements in her as in the homeland of the Vedic tribes. And the latter place has not made a speciality of conserving the "Aryan" element in it, be it Nordic or proto-Nordic or the Alpine (Armenoid) or anything else.

Coming directly to the somatology of the people of Bengal, it is to be found that the Bengalees are on the average mesocephal-mesorrhin-medium-sized persons. As regards eye-colour, Dr. Guha reports that the majority of the Bengalees examined by him have got dark brown eyes (Nos. 2—3 of Martin), "the Pods have either black or dark brown eyes" and "there is a small p.c. of light clear brown (Nos. 6—7) among both the Brahmans and the Kayasthas."[2] But in a note sent to the Science Congress recently held at Indore (1936), the writer of this paper has submitted data, that light-coloured eyes varying from Nos. 8 to 13 of Martin's nomenclature are to be found in Bengal among the orthodox Hindus. In the data submitted there is a subject with light grey (No. 13) eye-colour which Martin for practical purpose counts along with blue eye-colour. Thus the light eye-colour found by Dr. Guha in N. W. F. Province and with the Chitpavans can also be found with the Bengal Hindus, though these characteristics are rare.

Thus, as regards physical anthropology of Bengal, it can be said finally that there are different biotypes in this province as elsewhere, and that Bengal is not outside the anthropological circle of North India. This fact corroborates our statement that streams of immigrants have come to the lower Gangetic plain from the northern part of India from times immemorial, and Bengal has been always an integral part of Aryavarta, ethnically, socially, and politically.

Now, let us make a sociological enquiry for the origins of the castes into which the people of Bengal are divided. An investigation into the social history of castes of Bengal will show that these are the creation of Bengal *Milieu* ; caste names from the *Smritis* have been given to many of the social groups formed in modern times in Bengal, and the process is still being continued. In this way, the present-day social hierarchy of the Hindu society of Bengal has taken its rise.

Here, the question about the formation of a caste takes its rise. The Hindu society from its pristine days has got *Varna* system, and the Varnas differentiated the society into four groups according to professions. This division of the Varnas has been translated by the occidental indologists as division of the society according to the colour of the race. They find in it the racial fight between the white Aryans and the black aborigines. As the Brahman is described as 'white', they see the racial colour

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1. B. S. Guha in ***Census of India***, 1931, Vol. I. India, Pt. III. Ethnographical P. LVII.

2. B. S. Guha. ***op. cit:***

Regarding the physical anthropology of Bengal the following data are to be consulted: I. Bernard Davis: ***Thesaurus Craniorum***; Risley: ***Tribes and castes of Bengal***, R. C. Chanda: *Indo-Aryans* ; B. S. Guha and his colleagues in the ***Census Report*** of 1931 ; B. N. Datta—"Anthropological Notes on some West-Bengal Castes" in ***Man in India*** Vol. XIV, Nos 3 & 4 ; "An Enquiry for Traces of 'Darwin's Tuberclid' in the Ears of the people of Bengal"—*Ibid* Vol XIV, Nos. 2 & 3 ; "Craniometric examinations of some Bengal skulls" in the Report of 'Bengal Sahitya Sammelan' held in Calcutta, 1929; "An Enquiry into foot and Stature correlation of people of Bengal," a paper submitted to the I. Science Congress, 1935 ; "A Note on the presence of light-coloured eyes in the population of North-East India," a paper submitted to the I. S. Congress, 1936. J. K. Gon "Craniometric studies of some Bengalee skulls," a paper submitted to the I. S. Congress, 1936. T. C. Raychowdhury—"The Varendra Brahmans of Bengal" in ***Man in India***, Vol. XIII, Nos. 2 & 3, H. C. Chakladar—Measurements on Rahri, Varendra and Maithil Brahman. A. N. Chatterji—Reports of Students' Welfare Committee of the Calcutta University."

of the Vedic tribes depicted in this description. So far the analogy holds good. But a question may be asked here; As the ancient Hindu scriptures described the four Varnas of the four-fold society of the Hindus, then how should racially the men of the remaining colours be identified ? If the Brahman was the white Aryan and the Sudra the black aborigine, then what about the racial identities the red Kshatriya and the yellow Vaisya ? In that case, will the four colours of the four divisions be accepted as the four races of men as classified by Blumenbach ? Any way, the red and the yellow colours do not fall in the category of white tint, and the people of these colours are not classified as belonging to the "white" race by the anthropologists.

For this reason, instead of trying to find out that ancient India has recapitulated the race-fight that is taking place in America and in South Africa, and that the present-day different castes are groupings of the people originated by miscegenation between the white and black races in India, and that the greater is the blood of the white Aryan conserved in a caste the higher is its social status, we must try to read the Indian literature in order to find out the truth about the origin of the Indian caste system in a non-partisan spirit.

The Hindu scriptures speak of the Varna differentiations of the people according to quality (*Guna*) and work (*Karma*). The *Bhagavadgita* has clearly said that "I have created the four Varnas according to Guna and Karma" (4013). The *Mahabharata* while describing the four divisions according to four Varnas (Colours) says at last, "There is no speciality in Varnas...the Varnas have originated from the work" (Santiparva, Mokshadharma. Ch 184). In this passage, all the Varnas are conceived originally as of one Brahman colour, then according to characteristics and nature men have been differentiated into Kshatriya, Vaishya, Sudra, etc. Here, the people of the four colours are recognized as of the same origin. Again, the *Rigveda*, speaks of all men having descended from Nahusa (10-80-6).

That the ancient Hindu conception of the division of society into men of four colours has been metaphorical is being also recognized nowadays. Thus, the historian Vincent Smith says, "Varna, once a common name for all classes, perhaps taken from the colour of the garments that differed with different classes, as for example, white for Brahman...came to mean a caste in post-Vedic literature[1]"; Again the ethnologist-Sarat Chandra Roy says, "According to Hindu social philosophy, the preponderance of one or other of the three *gunas* entitles a man to be called respectively a Brahman, a Kshatriya, a Vaishya, and a Sudra. These are known as the four Varnas." The primary meaning of the word Varna appears to be "description" from the root *varni*, to describe. That this is the signification of the word *varna* as applied to the four social classes of India may, I think, be reasonably inferred from such passages as those in the *Mahabharata* (Santiparva, Sec. 188, verses 5-15) with reference to verse 5 which says that "the complexion which the Brahmans obtained was white, that which the Kshatriyas obtained was red" ...the commentator Nilkantha[2] explains that here words expressive of colour really means attributes (Gunas)"[3].

Again, there is a persistent mistake in translating the Sanskrit term "Varna" with the sociological concept "caste". Vincent Smith again says, "Most of the misunderstandings on the subject has arisen from the persistent mistranslation of Manu's term Varna as caste, whereas it should be rendered class or order or by some equivalent term[4]. Further, the Sanskrit term *Jati* has also been translated as caste, which mistake has been pointed out by Fick[5], who says that "Jati" is class, it is the same as the Greek *Gene*. Finally, we forget that the Vedic gods also have been divided into four Varnas (*Taittireya Brahmana*—3. 5. 5—2. 2. 91; *Satapatha Brahmana*—14. 4. 2. 23—25). Thus, the gods have been divided into four Varnas according to their Gunas. Surely no anthropological interpretation can be given to this division of the gods; nor can they be divided into castes. Hence, it is wrong to speak of the ancient Indian Varnas as castes: as these were originally classes. The ancient Hindu seers contemplated the division of gods and men according to their qualities. Since tenth century A. D., these classes began to be crystallized into endogamous social groups prohibiting connubium and commensality with other groups. From that time the old tribal designations gave place to designations according to localities.* Mohammedan invasion incrusted and intensified exclusiveness. In the 14th century A. D. Nagoji Bhatta[1] declared that there were two Varnas in Kaliyuga, and Raghunandan applied this in Bengal in the 16th century. Since that time, it is supposed that there are two Varnas in Bengal Hindu Society.

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[1] V. A. Smith—*Ancient and Hindu India*. Pt. I, p 36.

[2] Nilkantha—VI. II with Sankara's Bhasya; *vide* also Belvalkar & Ranade—*History of Indian Philosophy*. Vol IX; p. 414.

[3] S. C. Roy—'Caste, Race and Religion in India"—*Man in India*. Vol XIV. No. 2; pp. 194—195.

[4] V. A. Smith—*Op. Cit*, P 36.

[5] R. Fick—*The Social organisation in N. E. India*, translated by Moitra; pp. 331—235.

With the change of class into exclusive caste, the present-day caste-system of India took its rise. In Bengal, before the acceptance of Raghunandana's polity by the Hindus, persons could change their Varnas. Social history[2] of Bengal says that many Rajputs have entered into the Kayastha and Vaidya castes; some have left their old provincial caste subdivisions and entered a new phratry of the same Varna in Bengal. All these have been consciously done, and these took place before the final integration of the present-day Bengal Hindu society at the time of Raghunandan. Since then, those who are members of Raghunandan's polity are only recognized as "Bengalees"!

Now let us enquire into the status of a caste. A review of the history of the castes of India makes us see that the position of a caste depends on its economic condition. The economic status has got bearing on political influence which determines the social status of a given group. Everywhere the status of a class, and its present-day ossified Indian transformation caste, depends on the State. In India for a long time, the maxim of *L'etat ce moi* has been used by the king, hence the king as the embodiment of the State has raised or degraded a caste[1]. Hence, the castes are not static in their position. For this reason, the same caste enjoys different status in different parts of India.

Again, the fact that a man has not been bound to his caste by reason of his birth can be illustrated from the history of many of the castes. Ethnological investigations testify that members of the same tribe have entered different castes according to their status *viz.*, Nagar Brahmans, the Gujars, the Jats[2].

A caste is not based on race as asserted by Risley. The biometrical analyses of the castes referred to above have shown us that different racial elements have entered into the composition of a caste. Again, Risley in defence of his race-theory of caste status has said that the status of a caste stands in inverse ratio with its nasal index, *i. e.*, narrower is the nose higher the status of the caste[3]. In testing this dictum we see that in the Panjab and Rajputana the Gujar has got nasal index number 67, the Jat 69, the Khatri 69, the Macchi 70, the Arora 71, the Rajput 72. Here, the low-caste Sudras have got the lowest indices-

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* Designations according to locality seems to have originated very late in Indian society. It seems tribal system gave way to this system. Those castes that have abolished tribal system have accepted designations according to locality as in Bengal. The Brahmans do not seem to have developed tribal system like the Kshatriyas and others, hence even in post-Vedic age, they were designated according to place *viz. udichya* Brahman (*vide* Ficke—*Sociale Gliederung*)

[1] C. V. Vaidya—*History of Mediaeval India*—Vol. II p. 312.

[2] N. N. Basu—*Kayasther Varna-Nirnaya* (Kayastha Ethnology) p. 177. Mr. Basu quotes the "Karika" of Maladhar Ghatak that in the Bengalee year 892 two Rajputs named Sura Singha and Rudra Singha were accepted as Kayasthas and they became the founders of the family of the Dattas of Raina (Dt. Burdwan). The case of the Ham-Vaidyas of Jessore are well known. The rajahs of Susunga (Dt. Mymensingh) have changed their original sept (Maithil) and have entered the Varendra Brahman sept of Bengal.

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[1] *Vide—A glossary of the Tribes and Castes of the Punjab*, based on Ibbetson's Census Report for the Punjab 1883. p 864; also H. P. Sastri's introduction to N. N. Basu's book entitled *The Modern Bddhism* P. 19.

[2] Regarding the Nagar Brahmans, *vide* the *History of the Nagar Brahmans* in Gujrati; also D. R. Bhandarkar (B. R. A. S. New Series, vol. V, 1909). The Bhandara weavers of Jodhpur State were originally Nagar Brahmans.; *vide Vaidya*, vol. II, p 436.

Regarding the Gujars and the Jats see *A Glossary of the Tribes and castes of the Punjab and North-west Frontier Province*, vol III.

[3] H. H. Risley—*People of India*, p. 28.

numbers and the Kshatriya-Rajputs the highest. In the United Provinces the Bhuihar 75, the Brahman 75, the Kayastha 57, the Chatri 78, the Khatri 78, the Kurmi 79, the Bania 80. In Behar, the Brahman 73, the Babhan 74. In Bengal, the Kayastha 70.3, the Brahman 70.4, the Chandal 73.9, the Sadgop 73.9, the Goala 74.2, the Kaibarta 76.2. In Bengal, we see the Sudra Kayastha has got comparatively a narrower nose than the Brahman, and the position of the so-called untouchable Chandal comes next to these castes. O' Donnel, the census reporter of Bengal in 1891, has truly said that "Risley's theory does not stand the test. His race-theory of caste does not get any help from statistics[1]".

Thus from the anthropological side we see that the castes are not homogeneous in their racial compositions, hence these are not based on race. The question of the so-called Aryan and the so-called Dravidian[2] does not enter into its composition. From the sociological side we see that the castes are social phenomena. The classes originally have been built from the Indian *ris*—the people. Originally the class was a Varna which metaphorically meant profession. Later on, the class was incrusted into caste prohibiting connubium and commensality with others.

In the Indian history, we find that the professions were organized into guilds (*Samghas*). Also, we hear of two kinds of guilds: Merchant Guilds and Craft Guilds[3]. The Guilds were acknowledged by the State as *Sreni-Bala*, and each guild like those of the classical and mediaeval Europe, had a patron god as its protector. In some cases, these patron deities became the hero eponyms of the caste or its ancestor.[4] It seems, that like those of the West, the Guilds in accepting some deities as their patrons were drawn in the religious orbit of the time. Hence, various injunctions and taboos were instilled in their midst.

Further, the perusal of the Indian social records leads us to see that the crafts took up different functions. These gave rise to various castes and subcastes when each guild being ossified became identified with a functional caste. The theory of the *Smritis* that these "castes" arose out of misecegenations of different Varnas is fiction. Since the Mohammedan invasion, we do not hear of the guilds but we hear of various functional *jatis* or castes as we would call them to-day. It seems, a foreign ruling power will not allow a parallel organization of the subject people to exist side by side with its own. Since that time, the structure of the professional Samghas remained, but the spirit disappeared. The Samgha, with its executive body,[1] is gone but the ossified structure remained as present-day castes! Of course, outside Bengal, many of the functional castes have the old organization in the shape of caste-*panchayets* with its elders, but in Bengal the system has disappeared. We do not hear about the *Gai* (Brahman headman) and the *Chai* (Tanti headman) any longer. It is said that the so-called untouchable Bauri caste worshipping *Dharma-Thakur* has as yet got a remnant of the Samgha organization in its midst. But the old guild organization as described in the *Smritis* does not exist any longer.

This is the genesis of the caste-system of the Hindu society. It is said that castes are still in the making[2]. New functions are necessitating organizations of new castes. In Bengal, the five groups of Baniks, Chasa, Dhoba, Kaith, Tanti, Khasta, Kaith or Kastha, Kayastha, Teli, Kalu, Vaidya, Lohar, Jali—Kaibarta, etc., all are instances of functional castes.

Thus we see, that there are tribal or ethnic castes, professional castes and functional castes. The theory that a caste develops from a Varna is a fiction. The position of a caste at present depends upon its economic status and the influence of political power that it can bring on the society. On this account, the change of the social status of the present-day so-called "depressed classes" due to the

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[1] B. N. Datta—"Das Indische Kasten System"—*Anthropos*, Bd. XXII 27.

[2] The Government *Census Report* of 1931 has abolished the nomenclature—"Dravidian"—It is renamed as "Mediterranean". Also see Eickstedt—*Rassenkunde und Rassengeschichte der Menschheit.*

[3] S. K. Das—*The Economic History of Ancient India.*

[4] Chitragupta, the ancestor of the Kayasthas, Viswakarma of the Karmakars, Dhanwantari of the Vaidyas were originally either the hero eponyms of those castes or their patron deities who were latterly accepted as ancestors.

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[1] Vide *Brihaspati Samhita*, XVII 7.

[2] H. H. Risley, *op. cit.* Jolly—*Recht and Sitte*.

coming Reform Act which gives them some political advantages is inevitable.

We have spoken of the injunctions and taboos beforehand. The sum total of these are known as *achara* in Hindu society. Brahmanism, *i. e.*, the orthodox religion of the Hindus demands certain achara from its votaries. The acharas may be called as the rules and regulations regarding the guidance of one's own conduct. It consists of injunctions and prohibitions. These prohibitions are the taboos of the Brahmanical society. These are not taken from foreign sources.* The "Mana" force of the Nagas of Eastern Asia or the ancient Egyptian influence has not contributed to the formation of the Hindu idea of purification and taboo. The source of the Hindu idea of purification known as achara is to be traced from the Vedas. All the Indo-European peoples[1] in the ancient times had definite ideas of purifications and taboos. India has never been an exception to these institutions. The notion of purification or achara is also to be found in the ancient Indian Buddhist and Jaina communities. The common Indo-Aryan notions of purification and taboo have developed into various forms of achara of different sects.

The idea of taboo is connected with class-domination[2] : class-spirit has fostered the notions of purification and taboos which have given rise to the question of untouchability. It is not a singular phenomenon of the Hindu society. It exists even to-day in the Polynesian society[3].

In resumé, it is to be said that a modern Indian caste is hereditary and an endogamous organization, with its own rules of conduct. In old days, the notions of purification and taboo coupled with the attitude of the dominant class towards various occupations determined the status of a class. To-day, caste class is an exclusive and autonomous body. It is a community by itself. Formerly, the State *i. e.* the king could change the status of a caste : now-a-days, economic prosperity and education, combining together, have again set the dynamic force of the Hindu society in motion, and the castes are shifting their positions. Again, the castes bearing the same names everywhere may not have the same anthropological origin. In Bengal, many present-day castes are of local evolution, though they have borrowed old caste names from the *Smritis*. This process of changing the old caste designations and assuming classical names from the *Smritis* is still going on. Thereby they are creating new fictions about their origins and elevating their status by taking classical designations. Again, it is to be said that the Hindus social hierarchy of present-day is divided not only vertically but also horizontally. Modern classes are growing within the body of the castes.

Finally, the perusal of the history of the development of the Hindu society shows that there has not been any *Sanatan Dhara* (permanency) in the Hindu-polity, rather society has been dynamic.

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* Vide the discussions about it by S. C. Roy in *Man in India*.

[1] Vide Hasting's *Encyclopaedia of Ethics and Religion* on 'purification' and 'Taboo'. Also W. Warde Fowler —*The Religious experiences of the Roman people*. P. 41.

[2] S. Freud—*Totem and Taboo*; Max Schmidt—*Voelkerkunde* P 345.

[3] Max Schmidt—*Voelkerkunde* P 345.

Meteors

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EVER since man appeared on the face of the Earth he has been a passive spectator of meteoric apparitions. In his earlier stages of civilization, while his keen eye-sight enabled him to follow in greater detail the glimmer of their luminous trails, their sudden appearance must have perturbed his "untutored mind" and set him to speculate upon their cause and effect. To him, no doubt, the phenomena must have appeared as the running away of unruly stars from the fixed positions assigned to them on the revolving dome of the firmament—hence the name falling or shooting stars and its equivalents by which they are still known colloquilly in nearly all languages.

At a later stage, when complexity of natural phenomena proving too much for his ever strained intellect, and imagination often outstripping his sagacity, he had to postulate the existence of spirits, good and evil, no wonder that he associated the flash of a meteor with the collision of good and evil spirits terminating in the annihilation of the latter.

Fairy tales and folk-lore stories are full of references to shooting stars as premonitors of deaths and disasters.

Though Chinese records going as far back as 644 B.C. give accounts of notable meteoric showers and meteoretic falls, it was perhaps the famous stone meteoric that was seen to fall at Aegos Potamos in 465 B.C.—sixty-two years before Lysander's victory over the Athenians—that suggested the true connection between meteors and meteorites and set people to seek for a rational explanation of the phenomena.

Plutarch, following Anaxagoras and Diogenes of Apollonia, regards meteors as due to a fall of celestial bodies. In his life of Lysander he explains the Aegos Potamos incident in a manner suggestive of a crude conception of the laws of circular motion; He says that "the heavenly bodies by a relaxation of the force of their circular movements occasionally go off their regular tracks" and eventually fall on earth.

Notwithstanding these facts, even as late as the middle of the eighteenth century, people stubbornly opposed the notion of extra-terrestrial origin of meteorites. "A stone that was actually seen to fall on September 13, 1786, at Lucé in France, was examined by the most eminent chemists of the day including the renowned Lavoisier, and was pronounced to be an ordinary terrestrial stone disfigured by lightning!"

It was due mainly to the publication of E. Biots' report on the great shower of April, 26, 1803 at L'Aigle that people began to believe generally that masses of stone and iron reach the earth occasionally from the death of space. All the same, however, when Professors Silliman and Kingsley of Yale College spoke about the fall of the Weston shower that had occurred on December 14, 1807, Thomas Jefferson, then President of the United States of America, is reported to have remarked, "Gentlemen, I would rather believe that these Yankee professors would lie than to believe that stones fall from heaven."

No one doubts nowadays the "celestial" origin of meteors and meteroites, and for this reason immense attention is paid in Europe and America to the study and investigation of meteorites.

There is no intrinsic difference between meteors and meteorites. Meteorites are meteors that have survived their flight through the earth's atmosphere. No account of meteors can be considered in any sense complete, if it does not lead up, at least, to a description of the phenomena that usually accompany the fall of meteorites. We propose first to give a brief account of the nature of meteors derived from the results of more recent research.

Careful observations spread over a number of years have revealed the fact that meteors are in general small objects that for the most part belong to inter-planetary space. They revolve round the sun, often in the wake of comets, disintegrated or defunct, and coming within the sphere of attraction of the earth, are drawn forcibly to it. In their mad flight through the atmosphere, they knock against the molecules of the air with such impulse and frequency that in regions above 80 Km. from the Earth's surface they glow with excitation and impact radiation, and below that level, when they slow down in their downward journey and meet with denser layers of air, they develop a compressed gascap or mantle in front of them, which, being charged with vapours emanating from their hot surface, contributes mainly to their brightness.

Not infrequently, and in a seemingly capricious manner, meteors in the latter part of their course undergo at several stages, sudden "bursts" of luminosity. Much of their heat being thus released they fall in effective temperature, and at last cease to glow altogether, passing off into the air as invisible vapour or falling on the ground as impalpable dust.

Satisfactory information about the nature of meteors could accumulate only very gradually. Even when the relation between heat and mechanical work was well established, and careful measurements yielded more or less reliable data of heights and velocities of meteors, and estimates of the amount of light received from them gave a rough idea of their masses, the upper limit deduced for their rise of temperature was much too high—of the order of tens of thousand degrees absolute! But the result was based mainly on unwarranted assumptions and conjectures. It was not until the most powerful instrument of modern astrophysical research—photographic spectroscopy—could be appropriately applied that accurate knowledge concerning the chemical composition and temperature of meteors was forthcoming.

Systematic observations by W. J. Denning, G. Von Niessel and, later by Prof. Charles P. Olivier and the American and other Meteor Societies, have led to the conclusion that the smaller meteors appear at an average height of about 110 Kms. and disappear at about 80 Kms. altitude, after an average flight of about 55 Kms. Much brighter meteors that come under the category of fire-balls or bolides appear at greater heights (about 140 Kms.) and penetrate to within 50 Kms; traversing on the average 300 to 320 Kms. lenght of path in air.

Unless a meteor enters the solar system from inter-stellar space, its velocity before entering the earth's atmosphere does not exceed 80 Kms. per sec. Sporadic meteors that do not belong to any definate swarm of periodic showers have been found to move with velocities bordering on 100 Kms. per sec. There is no doubt that such meteors are visitors from inter-stellar space.

Meteors like the Leonids (that appear to come from the direction of the constellation of Leo in November), whose orbital motion is opposite to that of the Earth, have a large resultant velocity and, therefore, move very fast and are bluish-white in colour. Those whose orbital velocity is in the same direction as that of the Earth, like the Andromedes (that appear to come from the direction of the constellation of Andromeda), have to overtake it and have, therefore, a smaller resultant velocity. Consequently they move comparatively slowly and are yellowish in colour. For the same reason more meteors are seeen in the small hours of the morning than before midnight.

As for their masses F. A. Lindemann and G. M. B. Dobson conclude from their calculations that it would take about 150 first magnitude meteors to weigh a gram. Modern writers however regard this as much too low an estimate and are in favour of conceding more substantial masses to them.

According to the latest estimates made by C. C. Wylie, twenty four million meteors, of magnitudes visible to the unaided eye, are consumed by the Earth's atmosphere every twentyfour hours. If we include telescope meteors, the number is increased to millions of millions. All the same, the increase in the earth's mass and size caused by the accumulation of their dust in millions of years is negligibly small!

Had it not been for the protection afforded by the air, life in any but the lowest forms, would have been an extremely precarious affair, as the impact of even the tiniest meteors would have sufficed to kill or disable instantly the largest living beings.

To be Concluded.

Unknown Tribes of the Shan States

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THE recent discovery of coffins containing detached human skeletons in a cave in the Southern Shan States by Dr. V. P. Sondhi of the Geological Survey of India about which a discussion has of late been made in a meeting of the Asiatic Society of Bengal will invite opinions from anthropologists. As one who has been working among the primitive and hitherto little known tribes of Manipur and Burma border, I may be allowed to offer a few suggestions—which, I hope, will throw some light on this much-discussed problem. I will not at present enter into the question as to what race the skeletons in these coffins belong to, pending detailed examinations of the bones and other associated articles found with them.

The first question which is suggested in my mind after reading the report is whether this cemetery is not the secondary burial ground of the 'unknown people'. It is well known that among some primitive people, specially in Assam, after the death of a man, he is buried for the first time within or outside the village according to the custom of the tribe, and after the decomposition of the fleshy parts of the body (after a year or more according to tribal custom) the bones are taken out in some cases with elaborate ceremonies and buried at the same spot or carried to a separate place for burial. This custom is still in vogue among some of the tribes of Manipur who also use wooden coffins chopped out of logs of wood. The reason for thinking the site of the discovery as a place of secondary burial is the absence of utensils, weapons, and other things of daily use which are in most cases buried with the dead in case of regular burial amongst the tribes of Assam. In the present case we find mention only of an earthen pot and a wooden implement which can also be given at the time of the second burial. In the absence of the description and illustrations of these two important finds and other necessary details it is very difficult to unveil the mystery of the unknown tribe. If the excavation had been carried on under the guidance of an able anthropologist of the area or neighbouring area no such puzzle could have arisen.

If from an examination of the human remains the experts are of opinion that it is a case of first burial, our first assumption of the secondary burial based on insufficient data now available may be left aside. At the present moment, it is only possible to pick up several cultural traits from the report and try to find out which of the neighbouring tribes possesses most of these characteristics and probably this is the only method in the absence of other data left to us to come to any conclusion about the nature of the unknown tribe.

These unknown people are reported to have 'kept well out of sight of the civilized men and away from the latter's habitations and they approached the villages and fields at night and decamped with paddy'. These characteristics are also found amongst some of the tribes of Manipur who live in the secluded spurs of the hills and away from other human contact. In former times these tribes were in constant feud with each other and head-hunting and plundering raids were the rule of the day. But after the subjugation of the territory by the State peaceful condition prevails and warfare between the tribes are very rare.

The unknown people are also reported to have used crude earthen pots and wooden implements which are also found among the tribes of Manipur. No detailed comparison is possible here for want of necessary data and specimen.

The unknown people 'chopped at trees with an upward stroke'. The emphasis on this characteristic seems to be made on insufficient information, because

Dr. Sondhi only heard this remark from the villagers. It is probable that the method of chopping trees used by the unknown people is not in common use amongst the villagers of Melun, and so they noted one peculiarity of it among the unknown people. If the unknown men used both types of strokes, the villagers would note only the new peculiar stroke. The primitive men of Manipur use both upward and downward strokes to fell trees.

The most important of the characteristics is the method of the disposal of the dead by the unknown people as collected from the report. A comparison of this method of disposal with those of the Manipur tribes will be made in the following paragraphs :—

"In certain villages of the northern Lhotas rich men were till recently buried in wooden coffins called "boats" (orhung) cut out of one log of wood......"[1]

"Some of the Konyaks use coffins of the (above) type, and the Kalyo-Kengyus, also seem to use a dug-out receptacle for the bodies of the dead while they are kept in the house during the desiccation process..."[2]

Amongst the Thadou Kukis of Manipur "the corpse is (then) washed and wrapped in a cloth and placed in a log of wood which has been hollowed out to make a rough coffin. It is covered with a rough plank at the time of burial".[3]

Amongst the Lushei-Kukis "the body is placed in a box made by hollowing out a log, a slab of wood is placed over the opening, and the joint is plastered up with mud". The coffin is kept within the house and after some time "when it is thought that everything but the bones has been destroyed, the coffin is opened and the bones removed..."[4]

"Amongst some of the Kowpoees the side of a hill is excavated for the reception of the coffin and the vault is filled and closed with earth and stones".[5]

The Old Kukis of Manipur in general bury their dead outside the village. Formerly a wooden coffin from a log of wood was made for the receptacle of the body, but nowadays wood is in great demand in the local market and so the use of wooden coffin is becoming obsolete amongst these tribes. The coffin is still used only in the case of burial of a rich man or village officers. Secondary burial is practised amongst some of the tribes, *viz.* the Koms, the Tangkhuls, etc.

The traditional origin of the Manipur tribes is from the south, and stories still current amongst them show that they came from the south-east. Moreover, they are culturally more nearly connected with the people of the south-east than with any other people.

Another point of importance is the wandering habit of these tribes. Their migratory instinct urges them to change places at intervals of several years and settle in a new surrounding. This habit is still strong amongst the people and new villages are started as soon as they get a suitable site. But this urge is now practically suppressed by the State authorities and they have to settle down in the State.

Another evidence of the tribe's migration in the direction of the present site is that when King Nursing was Raja of Manipur he had driven out many of these hostile tribes from Manipur, and these primitive tribes at that time entered the Shan States and settled there. But after some time they again returned to Manipur, repelled by unhealthy surroundings and lack of better lands in that State.[1]

There is another evidence of the contact between the Manipur tribes and the Shan people. In this connection the invasion of Manipur by the Shans may be quoted from an earlier authority. "We know from the chronicles of Manipur that raids and reprisals marked the relations of the hill villages with the people of the valley from the earliest times...The Shan invasion of Assam is dated by Ney Elias[2] some time after 1220. We cannot now estimate the effect, if any, of these great movements upon the inhabitants of the hills of Assam. The cruelties perpetrated by the Shan leaders upon

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[1] Mills. J. P.—*The Lhota Nagas.*—p. 157, London, 1922.

[2] *Ibid.* footnote p. 158

[3] Shaw, W.—Notes on the Thadou Kukis, *J. A. S. B.*, Vol. XXIV. No. I, p. 33, 1928.

[4] Shakespear, J.—*The Lushei-Kuki Clans*, p. 84, London, 1912.

[5] Hodson, T. C.—*The Naga Tribes of Manipur*, p. 148, London.

[1] Brown, Dr. R.—Selections from the *Records of the* Government of India, Foreign Department, No. LXXVIII. p. 44. 1870.

[2] Elias, N.,—*History of the Shans* p. 18, 1876.

Naga villages[1] who attempted to resist their advance are perhaps enough to enable us to understand that these movements did exercise—in the long run—a very profound influence upon the hill people"[2] We may also suggest here that the Shans might have taken captives, after the raids from this place, who died out in the long run only leaving its burial place.

In concluding this paper I may point out that the unknown people probably had some connection with the tribes of Manipur or it may also be possible that a tribe of Manipur in the course of its migration had settled at that secluded spot and left their cemetery to puzzle the scientists of the future.*

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[1] Gait, E. A.,—*History of Assam*. p. 74. 1906.

[2] Hodson, T. C.—*The Naga Tribes of Manipur*. p. 17, 1911.

* The news of Dr. Sondhi's discovery of the 'unknown tribe' appeared in SCIENCE AND CULTURE, Vol. 1, No. 7, pp. 421-22—Editor, Sc. & Cul.

Muddy Water of the River Hughly

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SUGGESTION has been made to shift the source of supply of filter water of Calcutta further inland. This suggestion came when Calcutta public complained of higher salinity in drinking water. Such higher percentage of salt in drinking water is ascribed to greater influx of sea water, also to greater evaporation due to rise in temperature during the hot months. We at the garden, during the last April before the bursting of the first nor'westers—which this year is a harbinger of much coveted monsoon—had to use such saline water of the river that it was considered to be an efficacious antiseptic for nasal and mouth wash. At this time came the suggestion of the Chief Engineer to carry the intake pipe in future further up the river to avoid the inconvenience of the public due to overdose of salt in drinking water. Such a suggestion is welcome. But will the yearly trouble of drinking water of Calcutta be over by such a course? I may point out again that the trouble is more of a biological nature and of a more permanent character, which appears every year during the hot season. This trouble cannot be tackled purely by engineering skill. The biological condition of water is intimately connected with the muddy water of the river Hughly, which prevails mostly from June to November. This muddy water during the monsoon, as it flows down, brings along with the tropical rains and melting of the snows at the sources of the Ganges enormous volume of fresh water and with it millions and millions of germs of bacteria, algae, protozoa, and iron bacteria which are transported far and wide. Considerable quantity of these germs finds access to the settling tanks and finally to the filterbeds. Thus the trouble, although not visible and felt at present while drinking water, is of a more harmful nature than overdose of salinity experienced during the hot weather before the advent of the rains. The present difficulty at this part of the year is to maintain transparency normal to clear water. To get rid of this muddiness of the water of the Hughly is a stupendous task to people entrusted with the maintenance of the filterworks of Calcutta. Thanks to D. Waldie who by his prolonged investigation on the muddy water of the Hughly prescribed a surface coating of Palta sand with its vital layer evidently as the best final surface layer for filtering operation and avoiding mud after the chemical treatment of the river water usually practised. Waldie concludes, "The Hughly water during the rainy season could not be filtered without unusual difficulty, and that arising from a peculiarity in the water which I connected with the peculiar distribution of the rainfall in this country, though I could not then explain the cause: it was a matter of fact whether it could be explained or not. Plans proposed to overcome this difficulty, supported by experience of water filtration in England, I declared, would be useless, because the water was different and English experience therefore not applicable.

"One special contrivance, which it was alleged would be effective for the purpose, I had tried and had given my opinion that it was worthless for the purpose. The best plan for filtering the water of the rainy season as it presents itself in nature, I concluded, would be by the use of the Palta sand, properly managed, which includes a proper relation between the amount of filtering surface and the quantity of water to be filtered. All of these statements and opinions I still adhere to, as they were conclusions drawn from the observation of facts, the highest and only true authority from which scientific conclusions can be drawn."

I confirm Waldie's results although his experiments were carried on since the inception of Calcutta filterworks in the early part of 1870.

But again, this filtering surface is exposed to danger of interference and finally, rupture of this important layer due to deposit of loads of organic germs resting on this surface. Thus vegetable and animal organisms after the quiescent period during the monsoon start their life-history afresh. The vegetable organisms, chiefly algae, exhibit in the filterbeds three phases of development. First, the autumnal phase leading to germination of spores, secondly, the juvenile phase of vegetative growth, and thirdly, the reproductive vernal phase—leading on to fructification and fragmentation. The last phase reaches its zenith during the hot months before the advent of the rains. Rain sets in accompanied by storms, cyclones, etc., and frequently floods due to overflow of the rivers as a result of onrush of huge volume of water at the sources of the rivers. All these aid in distribution of reproductive bodies of bacteria and smaller members of plants and animal kingdoms. Thus the organisms repeat their life-history year in and year out. The greatest trouble is experienced during the hot months when these organisms in the settling tanks and filterbeds fructify and fragment and set up the activities of putrefaction bacteria. This activity appears before us in various tangible forms such as fishy or vegetable odour of the drinking water, brown scum settling at the bottom of glasses after the water is kept for some time in a glass, peculiar taste of water, etc. The danger of pathogenic bacteria being associated with these organisms and other defects of the water is avoided by chlorination. The inorganic contents of the water of the river during the monsoon as the following analysis shows are suitable for the organic growth of dormant spores :—

		Total mineral salts	Alkaline salt as chlorides.	Earthy salt as Carbonates	Silica
June	Ebb.	30.00	13.96	15.10	4.00
	Fl.	124.10	112.80	34.25	3.70
July	Ebb.	12.63	2.08	5.20	4.49
August		14.10	1.70	6.60	5.60

For 100,000 fluid grains. *(After Waldie)*

It is obvious that the main source of supply of drinking water to Calcutta should be the river. The trouble at the source is of chemical and biological nature. Without the control of these two factors apart from purely engineering skill no tangible betterment of the quality of the water, according to the writer's opinion, can be effected. The writer therefore again emphasizes the need of proper scientific investigation of the Calcutta filter water by an efficient batch of investigators in addition to the existing staff of engineers. The points are raised with a view to enlighten the city fathers with some of the biological facts connected with the filterworks of Calcutta. The trouble although at present in keeping with the season and life-history of organisms is not visible in definite form, yet it is there; and after their usual migration and resting period, they would burst forth during their vernal phase in proper season to cause the mischief which becomes the subject of deliberations every year. A scientific age demands scientific tackling of facts to mould nature for the benefit of human beings.

Professor Niels Bohr on the Neutron Capture and Nuclear Constitution

N. K. Saha

In his address delivered on January 27, 1936, before the Copenhagen Academy, Prof. Niels Bohr (*Nature*, Feb. 29, 1936) has put forward a strikingly original view on the mechanism of nuclear transformations caused by the impact of neutrons or charged particles (α-rays, protons, etc.), with heavy nuclei, or by the action of γ-rays. The fundamental feature of the new view-point seems to be that in such nuclear reactions he pictures the excess energy of the bombarding particle as first being rapidly divided among *all* nuclear particles with the result that an intermediate compound system is formed, and for some time afterwards no single particle possesses sufficient kinetic energy to leave the nuclear system ; the possible liberation of a proton or an α-particle or the escape of a neutron from the intermediate compound system is then regarded as a subsequent complicated process in which the energy happens to be again concentrated on some particle on the surface of the nucleus : or it is possible that the system may pass to a final stable state and give out the excess energy as γ-rays

Prof. Bohr arrives at this conclusion from a critical study of all nuclear reactions and specially those of the artificial radioactivity induced by the impact of neutrons with heavy nuclei which have been extensively studied by Fermi and his co-workers. One of the typical results of such reactions is the surprisingly large effective cross-section of collision for neutron-capture, and consequently a duration of the neutron-nucleus encounter which is large compared to the interval the neutron would take in simply passing through a space region of nuclear dimension. To account for such large duration of encounters Bohr postulates first the formation, in such encounters, of a compound system of considerable stability. A possible later breaking-up of this system with the emission of a material particle or its readjustment by the emission of radiation is regarded as a separate process.

A second typical result of neutron impacts is the non-selective character of capture of fast neutrons by the nuclei and a strikingly selective capture of slow neutrons. In the usual view of excitation of nuclear states, the excitation is attributed to the elevation of quantum state of an individual particle in the nucleus. In the present picture, on the other hand, it is assumed that the excitation corresponds to some quantized collective type of motion of all the nuclear particles taken together. In the ordinary emission of γ-rays the nuclear levels concerned are probably the states of such collective motions of the most simplest type. But in such strong excitation processes as in the neutron collisions, the phenomena are much more complicated. Here with the increase of the total energy of the nucleus the distance between the neighbouring levels would be much smaller. If, moreover, the probability of escape of material particles from the nucleus becomes comparable with the radiation probability, the width of the levels would considerably increase. Such a condition is expected to arise in the case of impact of high speed neutrons with heavy nuclei where the effective cross-section of scattering is several times larger than the cross-section of capture. The distance between the energy-levels in the energy-region concerned also rapidly diminishes. As a result, in such cases the energy-levels may not at all separate and this may give rise to a neutron-capture of very non-selective character, as has really been observed in such cases. But if the velocity of the incident neutrons decreases, the probability of neutron-escape also correspondingly diminishes. Further, the distance between the energy-levels in the region of low excitation also increases. In this case, therefore, the levels of the intermediate states would become sharper and they would approach more and more the nature of ordinary γ-ray-levels in this respect. This conclusion is strikingly confirmed by the exceedingly selective character of neutron-captures observed for very small velocity of the incident neutrons.

Another interesting feature of the present hypothesis of neutron-capture and nuclear excitation is that the subsequent ejection of α-particles, or protons by the intermediate compound system is here regarded as a separate concentration process for the excess energy, and so no decisive conclusion can be made from this regarding the presence of such particles in the nuclei under normal conditions. Thus the frequent appearance of α-rays as a result of natural and artificial disintegration of nuclei may be explained by the fact that energy is set free *by the very formation* of α-particles is often favoured, because it involves a smaller degree of *concentration of the excess energy* than the liberation of protons or neutrons.

Disintegration Electrons

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PARTICULAR interest has recently been shown in the discussion of the processes which cause the emission of electrons from radio-active elements. An attempt is made in this short article, to give an account of the present state of our knowledge in that direction in a general way.

It is well known that these electrons or β-rays as they are called, are of two kinds. One class consists of electrons emitted from the nucleus in the process of disintegration (disintegration electrons), and the other is composed of electrons ejected by the photoelectric effect of γ-rays proceeding from the nucleus when β-disintegrations occur. The latter class is commonly known as β-particles.

Before going into the discussion of the nature of the disintegration electrons, we shall briefly review the general features of the β-ray spectra as obtained by the so called focussing method. This consists in separating out β-rays of different velocities into a spectrum by the action of a perpendicular magnetic field. The first analysis of these magnetic spectra by Meitner and others showed a number of black lines, every line corresponding to emitted electrons of one particular emission velocity. Later on, a close examination of a spectrum obtained by Curtiss, revealed a general blackening or fog in addition to the black lines. At that time, it could not be said whether that fog was due to α-rays or β-particles having a continuous distribution of velocities.

It was Chadwick who first proved experimentally that the definite groups of electrons prominent on the spectrum, formed but a small fraction of the total emission. The main portion was a continuous spectrum of β-rays which could be identified as real disintegration electrons. In the original analysis, this was obviously neglected as the photographs taken without proper precautions failed to show the general blackening distinctly. Further RaB and Pb are isotopic and hence their absorption levels are identical and for the same γ-radiations, their secondary electron spectrum should be similar. Now if the black lines in the β-ray spectrum are due to the electrons ejected as the result of internal conversion of γ-rays in the K, L, M, shells of the disintegrating atom, such a spectrum of lead exposed to the γ-rays from RaB ought to be identical with the natural β-particle spectrum of RaB. Rutherford and Robinson verified this experimentally.

With a view to explaining the continuous part of the spectrum, it might be argued that there is a secondary scattering of disintegration electrons having originally the same energy, *viz.*, the maximum energy limit as shown in the spectrum. Ellis proved that it was not so. He measured the mean energy of the electrons from RaE (which gives very little γ-radiations) calorimetrically and found that the result agreed closely with the value of the average energy of the electrons as shown in the continuous spectrum of the same element. Again the rate of decay of RaE is found to be the same whether the fast or the slow electrons from it are taken as the basis of measurement. Thus the probability of ejection of fast disintegration electrons seems to be the same as that of the slow ones.

These considerations lead to the obvious conclusion that the continuity of the spectrum is a property of the nucleus.

The chief puzzle is now : how to account for this continuous part of the spectrum ? How could electrons be emitted from the nuclei with all energy limits between zero and a definite upper limit ? Do these electrons exist in the nuclei as such ?

From the general principle of quantum mechanics it is known that the wave function describing the motion of a system is anti-symmetrical or symmetrical as the number of elementary particles in each complex particle is odd or even. The nature of the wave functions also determines the statistics to be obeyed by the complex particle. If we assume the existence of free electrons in the nucleus and treat them as elementary particles, we find a result contrary to experimental evidence. In fact we are hopelessly muddled up in our theoretical investigations when we think nuclear electrons as independent entities.

In many cases of β-ray disintegration, the escape of a nuclear electron causes a violent excitation of the residual nucleus resulting in the ultimate emission of high energy γ-rays. The nature of these γ-radiations suggests quantized energy levels in the nuclei concerned. Now how could it be possible for the radioactive nuclei to emit electrons with a wide range of energy, when we find quantized energy levels in the emitting nuclei ? What happens to the excess of energy in the disintegrations in which electrons come out with less than the maximum energy ? If the energy disappears (which seems to be the case) well—this means a break down of the principle of conservation of energy.

Heisenberg has proposed a theory of nuclear structure in which the neutron has been treated as an elementary particle. It is suggested that in a nucleus of the β-ray type, a neutron is sometimes convertible to an electron and a proton. The electrons ejected in β-disintegrations are supposed to arise from such transformations.

Pauli tried to solve the problem by assuming that uncharged particles of extremely small mass called "neutrinos" are also emitted along with the disintegration electrons. These particles escape detection and carry away the balance of energy. This saves the principle of conservation, but in the absence of any experimental evidence on the existence of neutrinos, such a solution cannot be accepted.

Naturally there have been other speculations as to the origin of the disintegration electrons, but it is generally admitted that the problem is still unsolved and that energy is conserved in these transformations in some unknown manner.

Estimation of Error in the Localization of touch spot among the Santals

R. K. Mandal
M. N. Basu

We have here endeavoured to present in a regular and systematic form the result of our psychological observations of the Santals in Madhupur in Santal Parganas, Behar. We had been there in December 1933 as health-seekers and the contact with a number of Santals in the locality presented to us an opportunity to study them with scientific eyes. Unfortunately we had no anthropometrical or psychological appliances to carry out our experiments properly and we were constrained to do our work unaided by any instruments whatsoever. We made a provisional arrangement with celluloid pencils and tissue paper procured locally and carried out the investigations with these articles. The results of our investigations are put down below.

There is a combined influence of vision (imagery) and touch in the investigation of the space perception. The localization is also aided by kineaesthetic idea—though in a lesser degree.

The subject was made to sit at ease on a chair. His left forearm being placed on the table. On the forearm a square area was marked off (Fig. I). After giving him proper direction, a celluloid pencil was handed to him and his eyes were closed by means of a handkerchief. Then the point A (Fig. I) was touched after a warning signal by another celluloid pencil—the sensation being continued for a few seconds. After removing the pencil he was asked to localize the spot but he showed at a_1. In this way other trials were taken and were pointed out at a_2, a_3, a_4, a_5, etc. Similarly another point B (Fig. I) was marked off in the same area at a different place and the experiment was repeated as before. These points were marked by different kinds of ink and transferred on a tissue paper. Now the distance Aa_1 gives the amount of error in the localization of touch spot. Other such errors were noted.

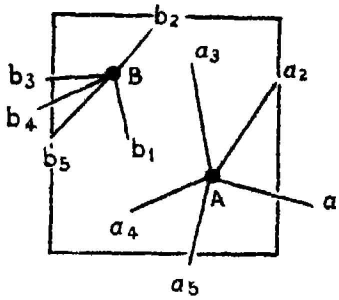


Fig. I.

The subject was directed to localize the spot from whence he perceived the sensation without any direct help from vision.

TABLE I.

Worked with point A.

No.	Pt. and marked pt.	Amount of error	Direction of error	Introspection
1	Aa_1	1·6cm.	R*	
2	Aa_2	1·5cm.	CR	
3	Aa_3	1·5cm.	C	
4	a_4	1·5cm.	CU	
5	a_5	1.1cm.	P	

Amount of mean error=1·38cm.

TABLE II

Worked with point B

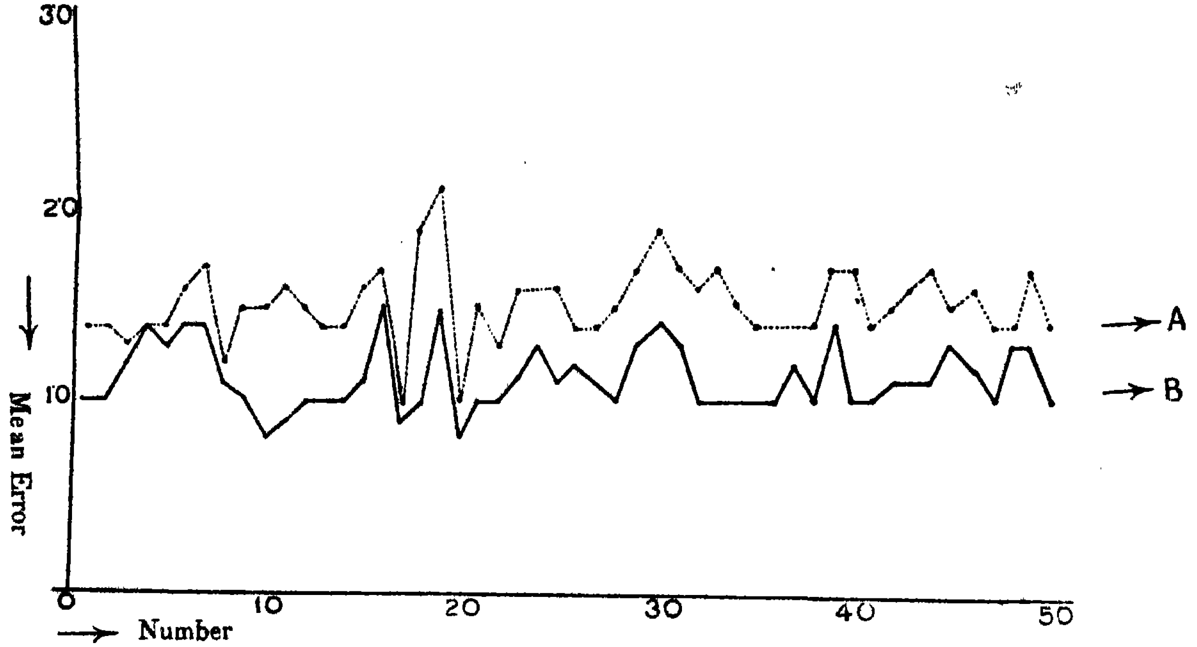
No.	Pt. and marked pt.	Amount of error	Direction of error	Introspection
1	Bb_1	·9cm.	RP	
2	Bb_2	·7cm.	CR	
3	Bb_3	1·2cm.	CU	
4	Bb_4	1·3cm.	U	
5	Bb_5	1·2cm.	UP	

Amount of mean error=1·06cm.

* R indicates the radial side of the hand.
C " " central part of the hand.
U " " ulnar side of the hand.
P " " peripheral side of the hand.

Now let us proceed to find out the amount of error of 50 individuals.

The amounts of error at A and B respectively are tabulated in a graph paper.



Graph showing the amount of Mean Error in the localization of touch spot at A and B.

▨ A
■ B

The mean value at A is 1·51cm. and at B 1·13cm.

There is a slight difficulty to discriminate the influence of vision (visual image) and that of the kineaesthetic sensation at first instance, but later on it becomes clear, the former becoming predominant.

It is practically found that the amount of error is less when the experiment was done at B in every particular individual.

Practice has got a very great influence upon the experiment and this is corroborated by the results of the subsequent experiments, *i. e.*, gradually the errors were less and less with the repetition of the experiments.

Notes and News

The Retirement of Dr. J. H. Hutton

Dr. John Henry Hutton, D.SC., C.I.E., of Assam, who has just gone on leave preparatory to retirement, was one of the most distinguished scholars in the Indian Civil Service. He belongs to the same class as Sir George Grierson, Sir Herbert Risley, Vincent Smith and others who made the Indian Civil Service famous in the world of scholarship, but alas! whose number has become very few nowadays.

Dr. Hutton comes of a Protestant family from Dublin and was educated in Worcestor College in Oxford. He joined the Indian Civil Service in 1909 and served in Eastern Bengal until 1912 when he went to the Naga Hills as Deputy Commissioner. From that time till 1929 when he became the Census Commissioner for India he remained there, mastered the languages of the Naga tribes and became the undisputed authority on their social and religious institutions. He made himself familiar with every part of the Naga country including the unadministered area of which he made a complete survey. For his work in the Naga Hills he was made a C.I.E. in 1920.

As Census Commissioner for the Government of India he published for the first time an accurate census of the aboriginal population of India, and in collaboration with Dr. B. S. Guha of the Indian Museum, published the Ethnographical volume of the *Census of India for* 1931, considered to be the most important contribution on the social and physical characters of the Indian people since Sir Herbert Risley's famous work in 1891.

As a scientist and well-wisher of the primitive races, among one of which he spent the most active period of his life, he strongly fought against the depopulation brought among the aborigines as a result of contact with civilization and it was mainly through his effort that Section 91 of the Government of India Act for 1935 dealing with the Excluded and Partially Excluded Areas was framed, but it is to be highly deplored that his further recommendation for the appointment of a special officer well acquainted with the habits and customs of the aboriginal people to advise the Government on all matters affecting their welfare as is done in all enlightened countries, having an aboriginal population, such as Australia, Canada, U. S. A., was not accepted by the Indian Government.

In recognition of his great work for Indian Anthropology, Dr. Hutton was elected the President of the Indian Science Congress held in Calcutta in 1935 and was also made a Vice-President of the National Institute of Science of India. He was also recently elected as the President of the newly formed Anthropological Institute of India. It is understood that he will succeed Dr. Marrett in Oxford, whose post has recently been raised to a Professorship.

Among his contributions the most important are:—

1. *The Sema Nagas,* London, 1921. 2. *The Angami Nagas,* London, 1921. 3. Leopard-men in the Naga Hills, *Smithsonian Report,* 1921. 4. Some carved stones in the Dayang valley, Sibsagar, *J. R. A. I.,* Vol. XX, 1924. 5. Some aboriginal beliefs in Assam, *Folklore,* Vol. XXXVI, 1925. 6. The use of stone in the Naga Hills, *J. R. A. I.,* LVI, 1926. 7. Diaries of two tours in the unadministered areas east of the Naga Hills, *Mem. A. S. B.,* Vol. XI, 1929. 8. *Census of India* for 1931, Vol. 1, pt. 1 (Report) and *Census of India* for 1931, Vol. 1, pt. III B. 9. Races of Further Asia, *Man in India,* 1932. 10. Cynotherapy, *Man in India,* 1932. 11. Mon and Munda in India and Beyond. *Proc. Nat. Inst. of Science.* Vol. 1, No. 2, 1935.

Protein Deficiency in Bengali Diet

In an address to the Calcutta Rotary Club Dr. H. E. C. Wilson, Professor of Biochemistry and Nutrition, All-India Institute of Hygiene and Public Health, pointed out that Bengali diet is sadly deficient in protein both in quantity and quality.

Dr. Wilson referred to the findings of the examination by Dr. Mitra and himself of some 3,000 children in Calcutta and some 1,200 in the Punjab by Dr. Bashir Ahmed, Assistant Professor in the Institute of

Hygiene. The essentials of the physical part of this examination consisted in taking the arm biceps girth, chest depth and hip width.

The conclusion, Dr. Wilson said, which one might draw from this investigation in Calcutta was that there was a deficiency somewhere but that a vitamin deficiency was not the major one. In the diet surveys carried out here no evidence of a marked deficiency in calorie was observed. The quantity and quality of animal protein was, however, markedly below European standards. Protein was the material out of which the body was built and belonged to a totally different category from such substances as vitamins. A deficiency of protein was bound to lead sooner or later to a reduction in the body mass or in subnormal growth.

An inadequate supply of building stones, Dr. Wilson continued, could only be made good by first class animal protein, such as milk protein products, meat, fish and eggs. One could not make bricks without straw and it should be brought to the attention of all that vitamins for all their importance would not *per se* build up a physique of optimum height and weight. The stressing of the protein factor in Bengal was by no means new. It was pointed out some 24 years ago by Major McKay when vitamins had scarcely come into field. It might not be the only factor but he was convinced from investigations in this country, in association with his earlier academic research in Europe on protein metabolism, that this foodstuff held a key position in the nutritional economy of the body.

Aeronautical Exhibition

The special exhibit, which has been formed at Science Museum, South Kensington, London by the Royal Aeronautical Society to mark the 70th anniversary of its foundation, has been extended for another month.

The exhibit is one of the most remarkable collections of aeronautical objects d'art, trophies, medals, engravings, stamps and rare or unique articles connected with ballooning and aviation yet shown publicly in Great Brintain. The collection has been gathered with the generous aid of many private collectors.

Among the objects shown are the first aeronautical passport, issued to the famous balloonist Green for his crossing from London to Holland by air in 1836. a fifteenth century account of Alexander the Great and his flying eagles, one of the earliest printed references to flying; the rare coloured specification of Henson's Aerial Carriage of 1842 which led to the first flight of a power driven model six years later—only two copies of this specification are known; the famous Schneider Trophy, won for all time by Great Britain; original letters, MSS. and drawings of Lunardi, Glaisher, Pilcher, Hargrave and other famous pioneers, including a collection of MSS . of Sir George Cayley with drawings of his glider originally designed in 1804: and the original Council Minutes of the Society, dated January 12th 1866: Plates and bowls, fans, snuff-boxes, buttons and handkerchiefs, decorated with aeronautical subjects, and a unique collection of medals are among the items which make this exhibit one of absorbing interest and historical value.

The Indian Anthropological Institute

The Indian Anthropological Institute has been formed in Calcutta with Dr. J. H. Hutton, D.SC., C.I.E., I.C.S. as the President, Dewan Bahadur L. K. A. Iyer, Rai Bahadurs S. C. Roy and R. P. Chanda as Vice-Presidents, Mr. K. P. Chattopadhyaya as Treasurer, Dr. B. S. Guha as Secretary and Dr. Panchanan Mitra as the Joint Secy. Among the members of the Council are Mr. J. P. Mills, Hon'ble K. L. Baruah of Assam, Dr. A. N. Chatterjee and Mr. N. G. Majumdar of Calcutta, Prof. Ghuriye of Bombay, Major D. H. Gordon of Rawalpindi, Prof. Barret of Rangoon, Prof. C. O. Hill of Colombo, Prof. D'Silva Correia of Nova Goa, Mr. W. V. Grigson, I.C.S. of Jubbalpore, Mr. Venkatachar, I.C.S. of U. P., Dr. D. N. Majumdar of Lucknow, Mr. N. Baksi, I.C.S. of Dhanbad, Prof. R. Krishna Rau of Vizagapatam, Mr. Aiyappan of Madras and Mr. S. S. Sarkar of the Bose Institute etc. etc.

The Institute proposes to publish a half yearly journal dealing with anthropological researches in India, Burma and Ceylon.

Distribution of Mohenjo-daro Relics

From the recent press report we understand that the 5,000-year-old relics of Mohenjo-daro will, it is anticipated, shortly be distributed to the various provincial museums in India. Dr. Fabri, the Hungarian archaeologist, who has been appointed special officer by the Government of India, has, it is understood, been entrusted with the work of classifying and cataloguing the finds of Mohenjo-daro. When this work is complete the relics will be distributed to the museums in India to give the people of the country an idea of the civilization of the Indus Valley.

Sind, the cradle of this civilization, hopes to have a large share of these collections. Now that Sind has acquired a new status, the Victoria Museum at Karachi is looking forward to considerable enlargement. The Karachi Municipality have earmarked a sum of Rs. 30,000 in the current year's budget for additions and improvements to the Museum and have also approached the Government for a permanent grant.

We quite appreciate the intention of the Government as this step may have some educative value to lay people all over India. But the amount that will fall to the lot of each museum will necessarily be so small that we doubt if the desired result will be achieved. On the other hand, the difficulties of the student who wants to undertake a systematic study of the Mohenjo-daro culture will be immense, as he will have to tour to the different museums to examine the relics. We feel that it would be a move in the right direction if the bulk of the collection is housed in one museum, and no doubt the Indian Museum, by virtue of its all-India jurisdiction, is the best place for this purpose. Or else, they may be kept at Delhi to form the nucleus of a specialized pre-historic museum, like the Central Asian Antiquities Museum, which was built to receive the antiquities recovered by Sir Aurel Stein during his expeditions to Central Asia.

Excavations in Travancore

Ruins of temples at Trikkakara in north Travancore popularly believed to have been built in the time of Mahabali, the legendary king whom Vamana the incarnation of Vishnu conquered and dethroned, are now being excavated by the Travancore Archaeological Department.

It is reported that a whole wall measuring about 580 feet in length and 3½ feet thickness, and the ruins of two temples and large chambers adjoining the wall have been unearthed. From the inscriptions discovered in the temples it is inferred that these relics cannot belong to later than the 16th century.

These excavations which are one of the largest of their kind in South India are evoking considerable public interest. The famous Vishnu temple at Trikkakara is the subject of hymns by south Indian saints.

The Date of Indus Valley Civilization

The date of the Indus Valley Civilization has not yet been fixed with accuracy, and scholars are trying hard to find out the exact date. The latest venture is that of Dr. C. L. Fabri of the Archaeological Department, who, addressing a gathering at Karachi, announced that a study of six important pictographs out of 300 in his possession had enabled him to put back the date of the Indus Valley civilization by 300 or 400 years. The civilization was about 4,636 years old its date being in the neighbourhood of 2700 B.C.

With the help of lantern slides Dr. Fabri, it is reported, traced the similarity between old Grecian and Mesopotamian culture and the Mohenjo-daro culture. He concluded that there must have been an overland caravan route linking the west to the east and a flourishing trade between them. Dr. Fabri also explained the startling similarity between the religious ritual of Crete and that of Mohenjo-daro. The bull grappling feats in which the Cretans revelled, many times offering themselves as sacrificial fodder to the deities, had its parallel in far off Sind. The frescoes illustrating these rituals resembled one another closely. The Indus Valley people, he thought, lived at the end of the stone age as hardly any metal implements had been found at Mohenjo-daro though there was a plethora of stone implements. These people were not a martial race but were engaged in the peaceful avocations of potters, fishermen and traders. Mohenjo-daro was a beautifully planned and laid out city whose lanes and perfect brickwork were the admiration of present archaeologists. We await with interest the discoveries of Dr. Fabri, which will, it is reported, be published soon.

Industrial Investigations in India

The first annual report of the "Industrial Research Bureau of the Government of India which was published recently contains accounts of important and valuable research work in India, covering a wide variety of subjects. From a perusal of the report it will be readily admitted that the Bureau which has been working only for a short time has proved its existence amply justified, and it is with great satisfaction that one notes the large number of industrial problems vital to the interest of India that are being examined by the Bureau and the different ways in which further possibilities of industrial development of the country are being explored.

Properties of different paints; use of vegetable oils for lubrication or for fuel for internal combustion engines; examination of stands and gravels for use in cement; investigation of the construction of dry electric cells; analysis of Indian sands and felspars for the glass industry these are some of the research work dealt with in the report. (*a*) *Paint*—Three fences, each 180 ft. long, have been put up for test work. During the year 15 black paints composed of magnetic oxide of iron and other black pigments in different proportions have been prepared and exposed. Different kinds of white paints have also been prepared and will be subjected to tests in the open. Other types of paints with which tests will be made are lead, grey, green, and red oxide. (*b*) *Dry Cells*—Equipment is being obtained to experiment with ingredients obtained in India for the making of dry cells. Dry cells of well-known makes have been obtained and carefully examined. (*c*) *Glass*—So far the work done is of an analytical nature. For example, six specimens of coloured glass bangles of Indian and Japanese manufacture have been completely analysed. Further tests of a similar nature are now being made. In addition, eight samples of Indian sands have been analysed to determine their suitability for the manufacture of glass. (*d*) *Vegetable Oils for Internal Combustion Engines*—Arrangements have been made for obtaining suitable quantities of the following Indian vegetable oil—arachis, mustard, sesame, cotton seed, and castor, for examining the possibility of using them as lubricants. Supplies of oil of *punnal*, oil of *karanj* and inferior *arachis* oils were also obtained for trial as fuel in light Diesel engines. Internal combustion engines, both petrol and Diesel, have been obtained for these experiments. (*e*) *Building Materials*. (*Lime, sand, cement, surki*)—A comprehensive programme has been drawn up for making mortar and concrete tests. A large number of samples of sand and gravel have been collected from different places in India in order that the most suitable shall be selected.

Industrial intelligence is one of the functions of the Bureau. For instance, at the request of the Indian Central Cotton Committee ,an examination has been initiated of the possibility of manufacturing in India artificial silk and staple fibre. It is noted that the number of inquiries from industrialists has been disappointingly small. The report contains an important chapter dealing with co-ordination between the Bureau and the Imperial Council of Agricultural Research. Such important subjects as sugar, lac and vegetable oils are discussed. The concentration of sugar research at the Harcourt Butler Institute is referred to. One of the items of research being undertaken by the Bureau, however, is that of the use of molasses in lime concrete. Research on fatty oils is also in progress at the Harcourt Butler Institute. This is a subject which has been undertaken under the auspices of the Bureau.

Tortuosity of Rivers

A question of vital importance to irrigation is, Why do rivers wind? The Central Board of Irrigation wrote to authorities on irrigation in all parts of the world to collect data on this question, and some of the replies are given in their report. Mr. D. N. Sen Gupta, Executive Engineer, Bengal, pointed out that the Ganges began with a tortuosity of 10 per cent., then fell to five per cent. increased up to 30 per cent., dropping again to 15 per cent. It would appear that the tortuosity of the rivers increased as the discharge was reduced. There were many rivers in Bengal to be studied and so much data to be collected that it was not possible to investigate the subject properly unless special facilities were provided.

Two recent cases of river erosion at important towns in Bengal were quoted. There was the town of Sirajgunj, which was threatened with complete obliteration, part of the city being actually carried away, before the town was saved by the adoption of suitable bank protective works. On the other hand, the town of Noakhali had practically disappeared, for no attempt was made to control the river, owing to the cost in relation to the value of property involved being prohibitive. The Brahmaputra river had left its old course towards the end of the 18th century with the result that towns like Mymensingh had been adversely affected. In addition to such troubles that followed changes in the course of rivers, there was the fact that the districts served by them lost in health and prosperity, the soil being impoverished. Details are also given of the changes in a number of other rivers in Bengal. Embankments had been tried, but did not appear to have a marked effect in reducing the winding of rivers. Rivers might be arrested in their winding by providing protection to banks which were being eroded.

Irrigation in India

A report summarizing the work that is being done on irrigational problems in India has recently been published by the Central Board of Irrigation for India. The total amount of cultivated land in India depending on irrigation is about 40,000,000 acres and employs about 50,000,000 people. The value of crops produced in this irrigated area amounts to about Rs. 100 crores. Practically all this work—involving the building of over 75,000 miles of canals and distributories—has been developed in the last 60 or 70 years. When the present irrigation works are fully developed, the area benefiited will be about 50,000,000 acres (the area commanded by these works will, of course, be approximately twice as great).

Water-logging is recognized to be one of the most serious problems and it is reported that numerous experiments are in progress in different provinces to fight this problem.

On the question of land reclamation and prevention of land deterioration, it is stated that experiments had been carried out which showed that water containing soluble salts could be used for irrigation, provided there was calcium present in the water or the soil or in both. This presence of calcium salts prevents base-exchange action taking place between the sodium and calcium in the clay complex. The Research Committee have, therefore, decided that irrigation water with a salt content of more than 60 parts per 100,000 parts of water may be used without detriment to the soil, provided there is sufficient calcium present in the water, or in the soil, or in both. It was reported that a formula had been evolved at the Punjab Irrigation Research Institute which would indicate whether the water was suitable for irrigation or not. It was decided that above a salt content of 120 parts per 100,000 parts of water, there is no possibility of preventing damage.. Further work is now in progress in the Punjab and in Sind.

Malaria, in connexion with irrigation, was another problem that had to be dealt with. It was felt that there was not sufficient evidence to decide the cause of the increase in malaria in Sind. At the same time, agreement was reached that there should be close co-operation between irrigation and medical authorities to prevent malaria.

One of the most important steps forward under the aegis of the Board is the building of models in order to test out various theories for the control of rivers. The opinion was expressed that no single province could or should take an experimental work of that nature, and that it should be undertaken by a special research station financed from the centre to be organized by practical experts. Poona was suggested as admirably suited as a site for such a research station having the necessary facilities and a good climate. We are glad that the Board have at last realized the importance of a river physics laboratory. We have stressed it before. The question of location, however, should be carefully considered.

B. B. C. Charter Renewed

The British Government's decision on the charter of the British Broadcasting Corporation follows the main lines of the Ullswater Committee Report.

The charter will be extended for ten years from December 31. The number of governors will be increased from seven to 10. The salary of the Chairman will be £3,000 a year and of the other governors £1,000 a year. The Corporation's share of public receiving licences, which will remain unchanged at 10s. per annum, will be increased. It has also been decided that the share of the receiving licence revenue retained by the Exchequer for 1936 should be £1,050,000, exclusive of incometax, payable by the B. B. C.

The Government express the view that the Corporation should continue to refrain from commenting on current affairs both in its broadcasts and in the Corporation's own publications.

The Government approve the continued exclusion of advertisements and express the opinion that the responsible departments should take all possible steps to prevent the broadcasting of foreign advertisement programmes.

The Empire Broadcasting Service, the Government add, should be developed. The licensing of relay exchanges should be continued for three years, the Postmaster-General being given power to take over the relays afterwards.

A technical investigation of interference with broadcasting is to be completed as soon as possible and, if necessary, further powers will be sought.

The Government reject the proposal that the cultural side of the broadcasting estimates should be presented separately in order to facilitate the debate on them by the House of Commons.

The Government also approve that the Corporation's staff should be filled on the recommendation of the Selection Board, together with staff representation. As regards the Corporation's attitude towards their employees' private lives, the Government are of opinion that the general practice of the Civil Service should be followed.

Health of School Students

Till recently the Education Department of Bengal paid little attention to the health of students, and it is therefore very gratifying to find the Department taking interest in the matter. They have set up, it is pleasing to note, the scheme of medical supervision of school children in Government and Government-aided schools in Calcutta, and as it "has gradually become very popular with the students and the public has also begun to appreciate its value," we would like the scheme being worked in other parts of Bengal and in different provinces. Greater active attention ought to be paid in rural areas to school hygiene and local sanitary conditions by the authorities, because the peasants are mostly ignorant of their importance and the methods to follow and also due to the lack of necessary facilities in villages.

It is pleasing to find in the Press Note issued by the Press Officer of the Government of Bengal that "as a result of repeated examinations carried on by medical inspectors followed by the issue of reminder cards to guardians and by the introduction of a students' clinic, a distinct tendency towards diminution of defects amongst students in these schools is now noticeable. Lack of interest shown by the guardians in the health of their wards, social and economic conditions of many of the guardians, their ignorance and negligence, are some of the causes which are retarding a more rapid diminution of the defects." Of 5160 boys in 30 Government and Government-aided schools (High and Middle English) in Calcutta examined during 1934-35 by three medical inspectors, 2430 or 47 p.c. were defective as against 50 p.c. of the previous year (See SCIENCE AND CULTURE Vol. I, No. 11, pp. 635-36). Diseases of the eye, tooth, throat, digestive system, and malnutrition are as usual the common defects. 1706 boys or 30 per cent were suffering from defective vision; 570 or 11 per cent from dental defects; 1,209 or 23 per cent from throat diseases; a large number from diseases of the digestive system; and 1,705 boys or 30 per cent from malnutrition.

The popular notion, says the Note, that many of our boys are unfit for physical exercise is wrong, only 20 or 0.4 per cent of the boys having been found to be unfit for such exercise. Students must take some form of physical exercise daily at home. The present system of compulsory physical exercise in the school twice a week is not sufficient. It can only teach them the main principles and train them in discipline. Guardians should pay greater attention to the diet of their boys, which should be well-balanced and contain sufficient protein and all the vitamins. Milk must be included in the dietary of children and at least ¼ seer, if not more, should be taken by each boy daily.

An important feature of the scheme is the establishment of a students' clinic, which opened during the year. The curative measures proposed through the establishment of this clinic have not, however, fully developed yet. Efforts are being made to extend this scheme in the near future. The clinic affords treatment for defects of the eye, teeth, tonsils, ear and nose, besides general ailments of the heart and lungs, etc. The attendance of students was not very satisfactory, the clinic being situated in an out of the way place.

In conclusion we would like to draw the attention of the reader to the excellent lecture delivered by Lt.-Col. R. N. Chopra during the Bengal Education Week, February 1936, on School Hygiene (see SCIENCE AND CULTURE, Vol. I, No. 12, pp. 692-94) wherein he states that health is not acquired by heredity alone, but can only come by educative nurture, and proceeds to say that as we need firstly "the knowledge of hygiene and secondly the practice of hygiene," the three groups of persons who have special responsibilities are the parents, the teacher, and the taught. "On them depends the health standard of the new generation," and "the study and practice of health must form, from the first, part of every day life of the school."

Improvement of National Diet

Among the recommendations of the Mixed Committee of Nutrition of the League of Nations, to be submitted to the Assembly, are the following:

NOTES AND NEWS

In order to promote endeavours to secure an adequate provision for all their people of necessary and more especially of protective foods, the Mixed Committee suggests to the Assembly to recommend that Governments should encourage and support in every possible way the scientific study of nutrition problems with a view to ascertaining the optimum nutrition for each country, due consideration being given to differences of national economic structure, of climate and of available sources of supply.

They should take all appropriate measures to ensure that the latest information about nutrition is included in the teaching of medical students and that medical practitioners, medical officers of health and district nurses, conduct a vigorous policy of education and propaganda for the instruction of the general public in this subject. Support the Health Organization of the League of Nations, not only in the work of its technical committees, but also in its endeavours in the field of public health and preventive medicine to promote the application of modern nutritional science for the benefit of the different age and occupational groups of the population.

Consider what steps should be taken, whether at the public charge or otherwise, to meet the nutritional needs of the lower income sections of the community; and in particular the means by which they might ensure that adequate supply of food, especially safe milk, should be made available.

Consider what further steps might be taken to meet the nutritional needs of adults, unemployed or otherwise in distress. With a view to assuring purity of food and in the interest of public health, promote, so far as possible, the international unification of the technical analysis and control of food-stuff, and of the control of preparations sold primarily for their vitamin content on the basis of the work being conducted on standardization of biological products. Set up standards of reference and specifications for grading foods of all kinds according to quality and consider whether any modification of their general economic and commercial policy is desirable in order to ensure adequate supplies of foodstuffs and, in particular, to assist the reorientation of agricultural production necessary to satisfy the requirements of sound nutrition.

In order, *inter alia,* to ascertain how far existing national dietaries fall short of the new standards of nutrition, collect information on food consumption by families of different occupational groups at different income levels as well as in the distribution of the population by family income. Consider to what extent and by what means their national statistics of the supply and consumption of individual foods might be improved.

Irvine Committee Report

Some time back, H. E. the Viceroy appointed a Committee presided over by Sir James Irvine, to review the working of the Indian Institute of Science, Bangalore, with special reference to the purpose for which it was founded, and if any changes are considered desirable in the organization or activities of the Institute for better achievement of these purposes, to make recommendations accordingly.

We understand that the Irvine Committee has submitted its report, but it is still confidential. We quote below from a recent report in the *Statesman* regarding the meeting of the Council of the Institute of Science where Irvine Committee's Report was considered :

An extraordinary meeting of the governing council of the Indian Institute of Science, founded 27 years ago by the late Mr. J. N. Tata, was held to-day (July 2) under the chairmanship of Colonel C. T. C. Plowden, British Resident in Mysore.

All members were present including Sir P. C. Ray and Mr. Shyama Prasad Mookerjee, Vice-Chancellor of Calcutta University.

The main item of business was the consideration of the Report of the Committee presided over by Sir James Irvine. The report, which has been submitted to the Viceroy, reviews the activities of the Institute for the past five years and embodies suggestions for increasing the Institute's usefulness.

The report is still confidential but it is understood that the committee criticizes the administration of Sir C. V. Raman, the Director of the Institute. While recognizing Sir C. V. Raman's position as an eminent physicist, the Irvine Committee appears to have been impressed by the volume of personal hostility which, it is alleged, has been shown to him by a section of teachers and students of the Institute. This section, probably aggrieved at the changes made in the administration and personnel of the Institute, introduced by Sir C. V. Raman to economize expenditure and bring about proper co-ordination between the departments, submitted a confidential memorandum to the members of the Irvine Committee.

The Committee sat *in camera*.

The main recommendation of the Committee, it is understood, is to curtail the powers of the Director including those of making appointments, admission of students and grant of scholarships. In other words, it is intended to make the Director the professor in charge of his own department. It is further proposed to abolish the post of personal assistant to the Director.

The idea apparently is to follow the plan originally adopted by the Agricultural Research Institute at Pusa of having a non-technical man for co-ordinating the activities of the various departments.

It is believed that Sir C. V. Raman has submitted a note to the Council stating that such an arrangement would lead to disruption and indiscipline. He has also refuted the allegations of favouritism and patronage made against him.

Military Training for Students

A scheme calculated to improve the quality of recruitment to the University Training Corps and to promote enthusiasm among students of the University for military training, was recently adopted by the Senate of the Calcutta University. The scheme was the result of an inquiry undertaken by a Committee of the University who, in the course of their report, stated:

We recommend that military studies be included as a subject for examination in the University. There will be two examinations in the subject, one based on a junior and the other on a senior course of studies. No one will be eligible for the senior examination unless he has previously passed the junior examination. The course for each will be for a period of about two years. Each examination will be divided into two parts, practical and theoretical, carrying 100 marks each. Candidates must pass each portion separately. The examination will be open only to *bonafide* students of the University, who are also members of the University Training Corps. The practical portion of the work will be done in the Corps.

The practical examination shall be based on drill with and without arms, weapon training and tactical training according to a programme to be prepared by the Calcutta University Training Corps Headquarters. The course for the Senior Certificate Examination shall be of an advanced character. The examination shall be subdivided into three parts:

(i) General training;
(ii) Weapon training; and
(*iii*) Collective *training*.

The marks for the practical examination shall be awarded on—(a) final tests to be held at the time of the examination; and (b) records of service of the candidates.

The theoretical portion shall include the following subjects:—

JUNIOR COURSE

1. Military Hygiene and Camp Sanitation.
2. Map Reading and Field Sketching.
3. Discipline and *esprit de corps*.
4. History of the Army in India.
5. Badges and Symbols of Rank in the Fighting Forces.
6. Characteristics of Infantry Weapons.
7. Organization of the Army in India.

SENIOR COURSE

1. Selected Campaigns of the Great War.
2. Organization and Administration of an Infantry Unit in Peace and War.
3. Rolls of the Armed Forces of the Empire.
4. Characteristics of Military Weapons.
5. Imperial Military Geography with special reference to India.
6. Duties in aid of Civil Power.

It will be seen that the scheme adopted is fairly comprehensive and will go a long way to impart the necessary training to those who take it up.

Indian Science Abstracts

The National Institute of Sciences of India, Calcutta, resolved to issue a publication under the title *"Indian Science Abstracts"* with the sub-title 'Being an Annotated Bibliography of Science in India' every year. The first part of this publication has been issued, but the General Editor, realizing the impossibility of making such a publication complete without the active co-operation of all scientific workers in the country, requests them kindly to look through the 1st Part and see whether all their scientific publications issued during 1935 have been included in it. A great deal of matter for the 2nd Part is already in type, and if all the workers will kindly help by sending abstracts of such of their papers as have not been included in Part I, this will ensure making the record complete for all the scientific publications issued during 1935. *En passant* it may be noted that the publication is intended to include abstracts of all scientific papers published in India, as also of papers published abroad on work done in India or based on Indian material.

The arrangement of abstracts in Part I of the *Abstracts* is purely tentative, and suggestions for making the publication more useful will be gratefully received, and an attempt made to embody, as far as possible, such suggestions in the succeeding parts.

Instructions for the preparation of abstracts can be obtained from the offices of the National Institute of Sciences of India, 1 Park Street, Calcutta

Krishnakumari Ganesh Prasad Prize and Medal (for 1938)

The Council of the Calcutta Mathematical Society invites "Thesis" embodying the result of Original research or investigation in the following subject, for the Krisnakumari Ganesh Prasad Prize and Gold Medal for the year 1938.

"Lives and Works of the ten famous Hindu Mathematicians:—

(1) Aryabhatta, (2) Varahamihir, (3) Bhaskara 1, (4) Lalla, (5) Bramhagupta, (6) Sridhar, (7) Mahabir, (8) Sripati, (9) Bhaskara II, (10) Narayana.

The last day of submitting the thesis for the present award is 31st March 1938. Three copies of the thesis (type written) are to be submitted.

The competition is open to all nationals of the world without any distinction of race, caste or creed.

All communications are to be sent to the Secretary, Calcutta Mathematical Society, 92 Upper Circular Road, Calcutta.

The Origin of Syphilis

There has been no little controversy over the origin of syphilis in India—whether it is an ancient disease or a comparatively recent one, as believed by many (c. 1700 A.D., or a little earlier), and in the latter case how it was imported, in case it was not the outcome of the growth of a similar ailment, e.g. *upadamsha*, mentioned by Charaka. The fact that it is named *firinghi roga* in vernacular lends great weight to the belief that it was imported into this country by the west. Dr. D. V .Subba Reddy of the Medical College, Vizagapatam, in his thesis, "Antiquity of Syphilis in India," which was awarded the Charaka Memorial Prize (published in the *Indian Jour. of Venereal Diseases*, June 1936) deals in some details with this question. Such venereal diseases mentioned in ancient medical literature of this country, especially Charaka and Sushruta, as *upadamsha, prameha,* etc. are not really syphilis as might be believed by some. Syphilis as is known now-a-days as a specific injection was not understood by the teachers of Ayurved, until it was introduced in India in a virulent form from outside, perhaps by the Portuguese. Yet according to Dr. Reddy, the study of the ancient Indian medical literatures will hardly lead one to decide the question of its origin. "Any impartial and critical student who peruses the collection of passages from Charaka and Sushruta, bearing in mind their great antiquity and the difficulties in the way of his realizing their view point, will hesitate to assert that syphilis did not exist in antiquity. On the other hand, he is a bold man indeed, who can, on the basis of these fragments and echoes, definitely diagnose syphilis in ancient India." "Yet Charaka and Sushruta did not and could not have described syphilis and particularly syphilis as it manifests itself to-day." So far regarding the Indian origin of the disease. In the Appendix to this paper of Dr. Reddy (*In. Jour. Vet. Dis.*) the question how it came to Europe is dealt with and though "its origin is a question over which historians argue, the preponderance of evidence points to America as the source of the disease." There are reasons to suppose that this "disease of the Isle of Espanola" was first introduced into Europe when the crew of Columbus returned to Spain in 1493 after his voyage to the New World, infected with syphilis, and numerous chroniclers of Spanish America testify to the pre-Columbian existence of syphylis in America. But so far as the Old World is concerned, one thing is certain that "the march of the army of Charles VIII of France to Naples is, in the Old World, the real starter of the syphilis-motor."

Research Notes

Reflection of Radio waves from 6 to 60 Kms.

Prof. S. K. Mitra and Mr. P. Shyam (*Nature, 135,* 958, 1935) were the first to announce reflection of radio waves from a virtual height of 55 Kms. Recently, however, Mitra and Bhar (SCIENCE & CULTURE, *1,* 782, 1936) report echoes from heights of 20 to 30 Kms. These observations have now been confirmed by others. Colwell and Friend have recently reported (*Nature* 782, 9th May, 1936) echo reflection from heights 5 to 50 Kms. They employed two frequencies (1.614 Mc|Sec. and 3.492 Mc|Sec.) and found that generally there are reflections from two parts of the region at virtual heights of 5-30 Kms. and 40-55 Kms. The region has been found to be very erratic specially during the sunset and sunrise periods. The polarization and the intensity of the reflected echoes have been found to change with great rapidity. R. A. Watson Watt and his co-workers, using frequencies lying between 6 and 12 Mc|Sec., have also confirmed the results (*Nature,* 866, 23rd May 1936). Their observations show that the region from 6 to 60 Kms. can be subdivided into three distinct regions—(1) 6 to 14 Kms., (2) 15 to 50 Kms., and (3) about 60 Kms. The ionization of the intermediate region 15 to 50 Kms. height has been found to be replenished by local thunderstorms. The region near about 60 Kms. has been found to be independent of the lower two regions. Prof. Mitra has proposed to name this region as the C region and believes that the mechanism of Eccles—Larmor theory is unsuitable to account for these reflections (*Nature,* 867, May 23rd 1936).

Echoes have simultaneously appeared from these lower regions and the E and F-regions, and in order to physically understand the presence of these echoes it seems that we have to consider the view held by Kirby, Gilliland and other American workers that it is a case of partial reflection and partial refraction of waves. Further observations of this nature will throw a considerable light on the nature of mechanism of reflection and theoretical explanation of the problem.

G. R. T.

Quartz Oscillator as a Modulator of Intensity of Light

The modulation of light was so long effected by various methods both for high and low frequency ranges, Kerr Cell being used for frequency of the order 10^7 Hertz.

Recently H. E. R. Becker, W. Hanle and O. Maercks[1] have devised a method that excels others both in simplicity and ingenuity. The disadvantages when working with Kerr Cell are many: the liquid nitrobenzene used in the cell completely absorbs the violet and the ultra-violet regions of the spectrum. Further the applied field of high frequency sets the polar molecules in oscillation, whereby the temperature of the liquid is raised : and this does not favour double refraction. In the present method all these disadvantages are eliminated.

The underlying principle of the method is the production of stationary waves in a liquid column with a quartz plate oscillating with frequency ν and immersed in the liquid. In front of the oscillator and at a suitable distance from it is placed a reflector. The stationary waves thus set up vanish 2ν times per second. This property of the stationary waves has been made use of in the present case.

Parallel rays from a quick silver lamp are allowed to pass through a rectangular glass vessel containing the liquid in a direction parallel to the surface of the quartz plate. The intensity of light passing through the liquid column and parallel to the quartz plate is then modulated 2ν) times per sec. The emergent light is next focussed on the slit of a photo cell, the intensity of the light received being variable. The intensity is maximum at the instant at which the stationary waves vanish (*i.e.* when the resultant displacement at all points within the liquid column is zero). The photo cell can either be placed in the path of the direct emergent rays or at the first order spectrum. Thus the intensity of the light falling on the cell can be regulated.

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[1] *Phys. Zeit.,* *37,* No. 11.

Apart from its other advantages over the Kerr Cell, unlike in the case of the Kerr Cell the power expended in this case is very low, and the light incident on the liquid column can be increased in quantity by simply using a lens of wide aperture and varying the distance between the quartz plate and the reflector. The velocity of the ultrasonic waves only changes the distance between the successive nodes (*i.e.* the grating const.) and, therefore, changing the liquid the grating constant as well as the modulation can be varied..

The modulator can also be used for low frequency modulation. In this case the amplitude of the oscillating circuit is modulated by suitable device, and thereby the nature of the sound grating in the liquid column is also modulated at low frequency.

Thus it is expected that a method so simple and ingenious would in near future replace the more elaborate and expensive methods in use now-a-days.

D. C.

Vitamin K

A nutritional disease of chicks characterized by subcutaneous, intramuscular and abdominal haemorrhages, prolonged blood-clotting time and erosion of the gizzard lining was reported in detail by Holst and Halbrook early in 1933 from Barkley, California. This could be cured by the use of fresh cabbage. Subsequently Dam and Schonheyder from Copenhagen extended the work further and showed that haemorrhage is caused by the lack of a specific antihaemorrhagic factor which is different from vitamin C. This factor is a fat-soluble vitamin present in hog liver fat, in hemp seed, tomato, Kale, and to a less degree in many cereals. This antihaemorrhagic vitamin cannot be identified with the other fat-soluble vitamins A and D. Consequently they suggested the term vitamin K for this antihaemorrhagic factor. The vitamin occurs in the easily soluble non-sterol fraction of the unsaponifiable matter and can be taken up by 90% methyl alcohol from a petroleum-ether solution of the unsaponifiable concentrate. The quantitative determination of vitamin K is based upon the curative method. One unit of the vitamin is the smallest amount which during a certain time can bring a sick animal with a certain degree of morbidity to the normal state with respect to the clotting time. The authors suggested that lack of vitamin K causes a decrease of the clotting accelerating component in the blood. Recently Almquist and Stokstad (*Nat., 137,* 581, 1936) in investigating whether gizzard erosion is a true portion of the haemorrhagic syndrome or a separate disease not caused by deficiency of the antihaemorrhagic vitamin find that antigizzard erosion activity of Kale or alfalfa extracts was not proportional to their antihæmorrhagic activity. They find that the antigizzard erosion activity is localized in the saponifiable fraction. They therefore conclude that gizzard erosion is not a portion of the haemorrhagic syndrome, but a separate deficiency disease which may be corrected by a new fat-soluble factor found in the saponifiable fraction and probably vitamin in nature.

H. N. Banerjee.

A Colour Reaction for Vitamin D

At present the only test for the detection and determination of vitamin D in a substance is made by the physiological method. The method is tedious as skiagrams of the experimental animals have to be taken from time to time. Any reliable colorimetric method specific for vitamin D would therefore be very welcome. Dr. Halden and Mrs. Tzoni (*Nat., 137,* 909, 1936) report that they have developed such a colour reaction for the detection and determination of Vitamin D. The test is carried out as follows:

The solution of sterols, dissolved in benzene, petrol, ether or chloroform is evaporated to about 0. 25 c.c. in a test tube and 5 to 10 drops of a solution of 0.1 per cent. pyrogallol in absolute alcohol added. After heating on a water-bath, 2 to 4 drops of a freshly prepared 10 per cent. solution of dry aluminium chloride (extra pure) in absolute alcohol added and the heating continued. If vitamin D is present a deep violet colour appears at the bottom of the test tube, reaching its maximum intensity in about 4 minutes. For subsequent colorimetric determination the reaction product is immediately dissolved in absolute alcohol and a current of dry CO_2 blown over the solution to prevent oxidation. The test tube is then kept closed with a rubber stopper. Within an hour the colour does not change, so that quantitative determination can be easily done by means of an ordinary colorimeter. The smallest detectable amount by this method is about 0.0002 mg. of vitamin D and the optimal quantity for the colorimetric determination has been found to be 0.01 to 0.1 mg.

H. N. Banerjee.

On the Cadak Festival of Bengal

Recently two interesting communications on the Cadak festival of Bengal have been published. In the former one entitled "The Cadak festival in Bengal" (*Journal of the Asiatic Society of Bengal, Letters*, I., 397-406, pls. 9-10, 1936) Mr. K. P. Chattopadhyaya describes this festival which has been observed by him in full details in Beliaghata and, in a lesser detail, in Paddapukur (Bhowanipur) and Monoharpukur in Calcutta. The brief description of this festival is as follows: It begins a week before the end of the month of Caitra (March—April) and culminates on the last day of that month which also marks the close of the year in Bengal. One temporary thatched hut is constructed. In it an altar (*vedi*) is made and the phallic image of Śiva is placed in the centre of the altar. The devotees wear ochre-coloured cloth, and sacred thread with a root of the *kuśa* grass tied in a knot at the centre of the bunch of threads. They fast during the day-time on the 25th Caitra and instal the phallic image of Śiva on the same day. At night after the ceremonies of the day are over, the devotees eat *havishya*. From the 26th to the 30th Caitra Śiva is worshipped from the afternoon. Finally the priest immerses the image of Śiva in the Ganges. Along with these religious ceremonies there are some special ceremonies which are observed on days fixed for them. They are the following:—1. The swing over the fire. 2. The jump on thorns. 3. The jump on knives. 4. The piercing with arrows. 5. The marriage of Śiva, and fire dance. 6. The swing on the *Cadak* tree. 7. The propitiation of the resuscitated ghosts. In the concluding section the author opines that "the Manda festival, the Cadak and Dharma worship are closely connected, identical in many respects and have a common origin."

In the latter one entitled "The Cult of Kâlârkarudra (Cadakapûjâ)" (*ibid*, pp. 429-38, 1936) Mr. Chintaharan Chakravarty gives the details of this cult according to the evidence furnished by three manuals of ritual, *viz.*, Kâlârkarudra pûjâ-paddhati, Cadakapûjâ-paddhati and one ms. of Kâlârkarudra pûjâ. According to him the worship is performed in accordance with the Tantric rites. Among the peculiarities and special features of this ritual mention has been made of *mudrâbhañjana, adhivâsa* or *grhasannyâsa, dwârapâla pûjâ,* the lustration of the principal deity, the salutation of the principal deity by the "*saṅgas*" and the worship of various peculiar deities little known to students of Hindu mythology. The author believes that most probably this cult was not popular among the high class people during the time of Govindânanda and Raghunandana. For this reason we do not find the mention of this cult in the *smriti* works of these two authors. The author further believes that this cult is possibly a survival of some ritualistic practices of the *Pâśupatas* which were looked down upon by orthodox Brahmans. There is also the likelihood that a number of non-Brâhmanical and pre-Brahmanical practices survive in the Cadakapûjâ.

—*C. C. Das Gupta.*

On Korku Memorial Tablets

In an interesting communication entitled "A note on Korku memorial tablets" (*Man in India, 16*, 72-78, 1936) Rai Bahadur Sarat Chandra Roy supplements the information about these memorial tablets supplied for the first time by Major D. H. Gordon in *Man*, 19, 1936. He has collected this information in the course of an anthropological tour in the Betul district of the Central Provinces. According to him an individual tablet is called a *munda* and each collection of *mundas* is called a *Jagar* by the Korkus of the Betul district. He does not accept the theory of Major Gordon that the origin of these tablets is to be ascribed to certain ancient Hindu memorial stone-pillars and land-grants but believes that these tablets seem to have come to the Korkus from their prehistoric ancestors who used to erect menhirs and put up dolmens over the graves of their dead ancestors as some Mundâ tribes do up till now. He has further pointed out that the practice of setting up stone memorials in honour of the deceased is an ancient custom with some of the Mundâ tribes, such as the Mundâ, the Ho, the Bhumij and the Pahira of Chota Nagpur, as with the Korkus of the Central Provinces.

—*C. C. Das Gupta.*

Trans-uranic Elements

In 1934 Fermi[1] claimed to have produced an element of atomic number higher than 92 by bombarding Uranium with neutrons. The exact atomic number could not be determined; but the fact that the new radioactive product of half-period 13 minutes could be carried by manganese dioxide precipitate and some other tests pointed to its having an atomic number higher than that of uranium. There was also another product[2] of half period 90-100 minutes, which could be co-precipitated with rhenium sulphide.

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[1] *Nature*, *133*, 898, 1934

Grosse and Agruss[3] challenged Fermi's statement on the basis that these co-precipitation tests were inconclusive. They held that the products were isotopes of eka-tantalum, changing by β-emission into isotopes of uranium.

In view of this controversy it is interesting to find Hahn, Meitner and Strassman reporting in the April issue of the *Berichte der deutschen chenuschen Gessellschaft* that they have devised means to separate the products of disintegration from the parent substance and from one another. They find that the radio elements produced by Fermi are really transuranic elements, the longer lived product a mixture of homologues of the Pt-group (At. Nos. 94-96). Altogether 5 or 6 transuranic elements have been detected, *viz.*, two isotopes of 93, two of eka-osmium. one of eka-iridium and perhaps one of eka-platinum. The corresponding half-life periods are 16 minutes, 2.2 minutes, 12 hours, 59 minutes, 3 days and about 3 hours.

The first and third products are produced by fast neutrons, the rest more readily by slow. The process may be visualized as fast neutrons removing another from the nucleus and slow being absorbed. The product is stabilized by emission of β-rays with consequent increase in atomic number. Three Wilson Chamber photographs are given as evidence of β radiation by such elements.

D. P. Ray-Chaudhuri.

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2. *Proc. Roy. Soc.*. *146*, 495, 1934
3. *Nature*, *134*, 773, 1934

Shankland's Experiment and the Conservation Principles

On p. 642 in the April issue of this journal we have already reported on Shankland's[1] experiment which records an apparent failure of the photon theory of scattering. The experiment is a test of (*i*) the relation of simultaneity in the ejection of the photon and the appearance of the recoil electron and of (*ii*) an unambiguous connection between the directions of the two as proposed by the photon theory. On the results of his experiment we are forced to give up either (*ii*) or both (*i*) and (*ii*) together. The results are thus of a very fundamental nature and it appears that in seeking an explanation the conservation principles must be given up.

Dirac[2] is of opinion that an interpretation shall follow something on the lines of the dispersion theory of Bohr, Kramers and Slater, which denies the principles of conservation of energy for individual atomic processes, though it gives a statistical conservation. On such a theory both (*i*) and (*ii*) have to be abandoned.

Peierls[3] has recently suggested that there may yet be other interpretations than the one proposed by Dirac. Thus, according to him, (*i*) may still hold, but the relation between the directions of the photon and the recoil electron may be different from that given by the conservation laws. We can either suppose that (*ii*) breaks down for any frequency of the incident radiation or that (ii) holds for small frequencies, but deviations gradually appear for higher values of the frequency. On this latter basis we can give up not only the conservation principle for individual atomic processes, but also the statistical conservation principle.

A decision between these interpretations can only be made in the light of further experiment, and it will be idle to discuss here their theoretical merits and demerits.

D. P. Ray-Chaudhuri.

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1. *Phys Rev.*, *43*, 1936
2. *Nature*, *137*, 298, 1936
3. *Nature*, *137*, 904, 1936

University and Academy News

Calcutta Mathematical Society

An ordinary meeting of the Calcutta Mathematical Society was held in the Society's room on Sunday, the 12th July, 1936, at 5 p.m.

The following papers were read :—

(1) B. B. Sen—Note on the Stability of a thin plate under edge thrust, buckling being resisted by a small force varying as the displacement.

(2) M. De. Duffahel—A reduction formula for the functions of the second kind connected with the Polynomials of Applied Mathematics.

(3) R. C. Bose and S. N. Roy—On the four centroids of a closed convex surface.

(4) M. Ghosh—The theory of extensional vibration of a beam excited by the longitudinal impact at the fixed end, the other end being free.

(5) N. G. Shabde—On Infinite integrals of Bessel's functions.

(6) N. C. Chatterjee and P. N. Das Gupta—On the Irreducible invariant and covariant system of two quaternary Quadrics and two linear complexes.

(7) S. Ghosh—A note on the vibrations of a circular ring.

(8) R. C. Bose—The theory of associated skew rectangular pentagons.

(9) H. S. M. Coxter (*Cambridge*)—On Schlaflis generalization of Napier's Pentagramma Mirificum (*Communicated by Prof. F. Levi*).

Botanical Society of Bengal

A meeting of the Botanical Society of Bengal was held on the 9th July, 1936 in the Botanical Laboratory, Calcutta University.

The following paper was read :—

Mr. I. Banerji—Sterility in *Colocasia antiquorum* Schoft.

Royal Asiatic Society of Bengal

An ordinary monthly meeting of the Royal Asiatic Society of Bengal was held on 1st June, 1936.

The following candidates were ballotted for as Ordinary Members :

Sen, Jitendro Mohan, M. ED., B.SC., F.R.G.S., F.N.I., Assistant Director of Public Instruction, Bengal; 63, Lansdowne Road, Calcutta.

Ahmad, Alfazuddin, Khan Bahadur, M.A., Retired Assistant Director of Public Instruction, Bengal; Dhalhora, P.O. Tamluk, Midnapur.

The following paper was read :

1. P. C. Sengupta—*The date of the Bhărata Battle.*

The aim of this paper is to ascertain the date of the Bhârata Battle from the astronomical references in the *Mahâbhârata* itself. The author first gives an outline history of some of the notable researches for finding this date in the past, and shows that their results have been all inconclusive. He then states the three traditions for the date of the event., *viz.*, 3102 B.C., 2449 B.C. and 1421 B.C. ascribable respectively to Âryabhata I (499 A.D., Vrddha Garga (much earlier than Âryabhata I) and the astronomical writer of the *purânas*. The author mentions the names of some notable supporters of these three traditions. He then points out how important it is to find accurately the date of the Bhârata Battle for fixing the chronology of the *Vedas*, *Brâhmans* and the *Upanishads*.

The author next cites a system of consistent astronomical references from the *Mahâbhârata* from which he attempts an approximate solution of the problem as one on conjunction of the moon with the sun and some fixed stars. He finds that the approximate position of the summer solstitial colure of the year of the Bhârata Battle passed through the star *Regulus*, whence the year comes out to be 2350 B.C.—a result which fairly agrees with the tradition ascribed to

Vrddha Garga that Yudhisthir became King in 2449 B.C. He then examines the year 2449 B.C. astronomically by a consideration of the mean motions of the sun and the moon and proves that the lunisolar phenomena of the *Mahâbhârata* references did actually happen in 2449 B.C. He next calculates the apparent longitudes of the sun, the moon, and some stars for some days of the year 2449 B.C. and shows conclusively that the fight began on the 14th October and lasted till the 31st of the same month and that Bhisma expired on the 20th December, one day after the sun had reached the winter solstice. So far as our knowledge goes these *Mahâbhârata* references have not been used in any other previous researches. The author has supplemented his paper by citing some other *Mahâbhârata* references showing that there was a time in the history of Hindu India, when the summer solstitial colure passed through the star *Regulus* and the vernal equinoctial year through the star group *Pleiades*, for which the mean date is 2350 B.C.

The following exhibits were shown and commented upon:

1. CHINTAHARAN CHAKRAVARTI.—*Newly acquired Manuscripts on the Cult of Kubjikā.*

Kubjikâ, the name of an aspect of hte Divine Mother, worshipped in Nepal is not generally known to the world of scholars. The literature dealing with the details of her worship deposited in the Durbar Library of Nepal was brought to the notice of scholars by the late Mahâmahopâdhyaya Haraprasad Shastri in 1905. MSS. of this literature are not reported from anywhere else. Of late Royal Asiatic Society of Bengal has been fortunate in acquiring a number of MSS. which have tended to make its collection of the Kubjikâ literature a fair and a representative one. A brief account will be given of these MSS., a study of which is expected to throw light on a little known but interesting cult. At least one of these MSS., viz. the *Mahâ-kramârcana of* Ajitânandanâtha, disciple of Anantânandanâtha, appears to be unique.

2. M. HIDAYAT HOSAIN.—*A Persian stencilled wall-hanging Picture said to represent 'Umâr Khayyâm.*

A beautiful picture done on cloth, size 17″×17″, with a quatrain from the writings of Umar Khayyam.

3. PERCY BROWN.—*A metal Figurine of a Dancer.*

The figurine is 9½ inches in height and presumed to be of brass. Obtained from a Nepali dealer but rigin unknown. It appears to represent a form of Śiva but is very unusual in its treatment, although he holds the drum (*damaru*) in the shape of an hour-glass, and there is a serpent coiled round his neck, with another above his head. The statuette, although rather crudely modelled, is very spirited on its action, and the lively movement of the dance is vigorously represented by the position of the legs and arms, and the flying drapery.

An Ordinary Monthly Meeting of the Royal Asiatic Society of Bengal was held on 6th July, 1936.

The following candidate was ballotted for as an Ordinary Member:—

Bakht, Muhammad Sanuwar, Maulavi, Assam School Service, Anglo-Arabic Teacher, Government High School, Sibsagar, Assam.

The following exhibits were shown and commented upon:

1. SUNITI KUMAR CHATTERJI.—*A set of old Oriya Playing Cards.*

These round playing cards were in use in India,—at least in Eastern India,—before the coming of the European cards in the 18th century through the intermediacy of the Dutch. It is not known how old these round cards are , but judging from the fact that their symbolism is Hindu, they may be a nearly Hindu or native invention, like other sedentary games like chess and *pachisi.*. The number varies from 96 to 120 and more,—the present set exhibited has 96. For the heart, spades, clubs, and diamonds of European cards there are lotuses, conchshells, clubs (the gadâ of Vishnu), circles and squares; and different gods and goddesses also figure in these cards. Playing cards of this kind were current in West Bengal and in Orissa, and the making of them lingered on in Vishnupur in West Bengal till recently. These cards have now become entirely obsolete, and very few people, if any, now know how to play them. The late MM. Haraprasad Sastri procured a set of Vishnupur cards for the *Vangiya Sahitya Parishad* and wrote an account of the manner of playing them in the Journal of that Institution.

The present set comes from Orissa. The cards are made of cloth stiffened with a ground made of gum, and the designs—mostly figures of a god and goddess (or a human *nayaka* and *nayika*), frequently in an amorous situation—are painted in brilliant colours. Pictures of Jagannath and other Hindu gods used to be done on cloth in the same style at Puri, which pilgrims would carry home with them: now crude lithographs on paper have put an end to this form of temple art. The cards exhibited are small in size, being only about 2½ inches in diameter. Vishnupur cards are much bigger. They form very good specimens of Oriya painting in the traditional style, and they have a distinctive place in Indian miniature painting. Erotic scenes like those depicted in the present set are lacking in the similar type of round Vishnupur cards, three different sets of which I have seen. The symbols,—lotuses, conchshells, clubs, etc.,—are more in evidence there than human figures. The set exhibited may be fifty to eighty or even a hundred years old.

2. N. G. MAJUMDAR.—*A terracotta Toy-cart in the Indian Museum.*

This is a unique specimen of a terracotta toy-cart which has been in the Museum for many years. Its findspot is unknown. The cart has six passengers represented in relief including two women,who are all in festive mood and enjoying themselves. The party is engaged in eating and music, as may be seen from a tray containing eatables, a *tabla* and a harp. A similar example of a toy-cart has recently been discovered at Kosam in Allahabad District, and it is very likely that this one also came from the same place. On artistic grounds it may be placed in the Sunga period (about 150 B.C.) .

The following communication was made:

1. N. BARWELL.—*Influence of Oriental* MOTIFS *upon book-bindings in Europe from the 15th to the 18th century.*

From the earliest times in Europe leather was used to cover the boards which in fact formed the preservative cover for manuscripts. Prior to these protective measures literature was not preserved in a form to which the word 'book' could properly be applied. The earliest decorative bindings were those on which stamps were made from the impress of metal seals. The designs of these seals or dies tended to be heraldic in character. In the nearer east the art of Arabia and Persia lent itself to decorative book-binding; and ornament arabesque in origin and character reaches a high degree of perfection in the illumination of manuscripts and as an adornment to book lovers in Persia. The materials used for book covers in Persia were peculiarly suited for developing a design whose main characteristics are to be found similarly developed in ceramics, in textile fabrics, in embroideries and in chased metal work.

By the beginning of the 16th century in Europe objects of art of oriental workmanship, especially those from the Middle East, were finding their way to Europe where, from the first, they were highly prized. They entered Central Europe by the great Italian ports of Venice and Genoa. The Turks—never an artistic race—brought practically nothing of beauty with them : though they penetrated to the gates of Vienna and held many a Danubian position of strength from Budapest to the Black Sea. Oriental art, however, made a direct entrance into Spain; and by the Spaniards was carried to the north-west of Europe when they took possession of the Netherlands. Some slight influence is observable in Russian book-binding. But, for the most part, the influence moves through Italy into France and thence into England, where it greatly affects design during the 16th century.

The communication will be illustrated partly by specimens of work in possession of the Society, but more by reference to coloured and other reproductions of decorative book-bindings in Mr. Hobson's Book-bindiings in Cambridge Libraries, a work towards which the author, in some sense, personally contributed.

Book Review

The Solar System and its Origin—*By Professor Henry Norris Russell, Director of the Princeton University Observatory and Research Associate of the Mt. Wilson Observatory. Pp. V+141+12 plates. The Macmillan Company, New York. Price 8s. 6d.*

Professor Russell is one of the foremost of American astrophysicists and is well known for the lucidity with which he writes on intricate astrophysical problems. In the present book Professor Russell gives an excellent, short, and up-to-date account, without introducing mathematical technicalities, of this very fascinating subject. The book is divided into three chapters. The first one deals with the dynamical properties of the solar system. The solar system comprises nine large planets, 26 satellites (belonging to six of these planets), about 30,000 asteroids (as estimated by Baade), more than 100,000 comets, and innumerable meteors. This is a highly complex system, but whether there exist in space other systems like our own must remain (for ever) a matter of speculation, because even the nearest star is so distant from us that if it had any planets it would be impossible to detect them even with the most powerful telescope. The mass of the sun is tremendously great as compared to that of the planets—it is about 744 times the mass of all the planets together. Jupiter is by far the heaviest of all the planets (a little less than three times the mass of all the other planets), and also of the largest diameter. Jupiter also stands supreme in its contribution towards the angular momentum possessed by the solar system. Taking the Earth's orbital angular momentum as the unit, Jupiter's orbital momentum is 722—the total for the solar system being about 1200 units. The other things described in this chapter are the age of the Earth, stability of the system and the motion of the comets.

The second chapter is on the physical and chemical properties of the system. Of all planets, the Earth has the maximum density and Saturn the least. A measure of the flatenning at the poles caused by rapid rotation of a planet about its axis allows us to estimate the density distribution inside it. In this way it is found that Mars has nearly the same density throughout, the Earth more condensed (its central density is twice the mean density), Jupiter, Uranus and Neptune still more so and Saturn has the largest concentration towards the center. Jeffreys has estimated that Saturn possesses a central core (of density about 5.5), a little less than half the diameter of the planet. We next pass on to a discussion of the planetary surface temperatures and then to their atmospheres. The chemical composition of the Earth as a whole—which is taken to be the average of the chemical composition of the Earth's *crust* and of the Meteors—is discussed at some length and is compared with that of the sun. The general conclusion follows (p. 76)—"*The Earth, compared with Sun, is very poor in the atmosphere forming elements.* Put thus, they suggest their own explanation—that an immense amount of atmospheric gases have escaped from the Earth." The *escape velocity* from the Earth is 11.2 Km./Sec. while the mean molecular velocity for Hydrogen at 0°C is 1.84 Km./Sec., and 1.31 Km./Sec. for Helium. "Jeans' formulae, which are based on unchallenged principles of the kinetic theory of gases, indicate that the Earth should not at present be losing any thing, even Hydrogen; and this conclusion still holds, even if we assume that the temperature of the uppermost layer of the atmosphere is 100 degrees Centigrade (as indeed it may actually be, owing to the absorption of the sun's ultra violet radiation by ozone). Helium should be still safer against escape; yet there is conclusive evidence that the Earth is actually losing it" (p. 76). It may be worthwhile here to remark that the recent investigations of the upper atmosphere initiated by Appleton and his collaborators indicate that the temparature of the upper region reaches 1200 degrees centrigrade and possibly much more. This would make the Helium velocity about 3 Km./Sec. and *may lead to appreciable loss of Helium from the Earth's atmosphere.**

Among the planets free oxygen and water vapour are present only in the Earth's atmosphere. Moon has no atmosphere. The atmosphere of Venus is about equal in extent to that of the Earth, but consists entirely of carbondioxide with possibly a trace of oxygen and water vapour. Mars has a thin atmosphere mostly of water vapour and carbondioxide. There is no direct evidence of oxygen, but there is strong indirect evidence that the red colour of the planet is due to the surface rocks being oxidized to the red ferric oxide. Possibly, Venus represents a condition before life begins (presence of vegetation breaks carbondioxide and generates free oxygen), and Mars the last stages of life disappearing. The chapter closes by pointing out some unexplained problems connected with the spectra of comets. It is a most fascinating chapter full of information.

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* This problem may also have a possible bearing to Prof. Saha's recent suggestion (*Observatory*, June 1936) that the far ultra-violet lines of solar spectrum are possibly emission lines.

The third and the last chapter of the book deals with the theories of the origin of the solar system. The oldest hypothesis is that of Swedenburg and Kant and mathemetically worked out by Laplace. The planetesimal theory of Chamberlin and Moulton, and the tidal theory of Jeans and Jeffreys are then described. But all these theories and their later variants have grave defects, the most fatal being one about the distribution of angular momentum which is beautifully explained and emphasized by Professor Russell for the first time. The essential point in these theories is that at some past epoch the sun suffered an encounter with some star—the encounter being violent enough so as to lead to the ejection of sufficient mass from the sun (and the star) to form the planets. But for the collision to be of such violence, the star must have approached the sun fairly close—if the star was of the "sun's size and mass the perihelion distance could not have been much more than a million miles, or no ejection of matter would have taken place!" (p. 118). The encounter would give rise to an angular momentum per ton about ten times less than what is observed for the solar system. This is the most fatal objection for all previous theories, and Professor Russell at the end of the book makes two possible suggestions to overcome this difficulty. The first suggestion is that at the time of the encounter the sun was a binary star. This suggestion has its difficulties and Professor Russell calls it "not a promising hypothesis" (p. 137). In the last April issue of the *Monthly Notices*, R. A. Lyttleton has examined this suggestion mathematically and finds that it does not suffer from the objections feared by Russell. Lyttleton's paper may prove to be an important contribution on this subject.

The second suggestion of Professor Russell is a rather devastating one, for it suggests that the origin of the solar system is no separate problem but is bound up with the problem of the origin of the expanding Universe. The theory of the expanding Universe assigns to the Universe an age of about one or two billion* years. At or near this epoch the stellar bodies were crowded together in a very small volume of space and so must have suffered frequent encounters among themselves leading to the birth of planetary systems.

This is a most suggestive and stimulating book, full of facts brilliantly knit together so far as the present theories allow them to be done so. One really enjoys reading this book, and if possible one should possess it to read it over again and ponder over many of the suggestive problems that it presents.

D. S. K.

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*The *billion* in this book, like all American books, means a thousand million and not a million million.

Letters to the Editor

Structures of the Allotropic Modifications of Sulphur

In a previous letter, the results of studying roll sulphur, flower of sulphur, colloidal sulphur and milk of sulphur were reported by one of the present authors.[1] The conclusion was reached that the last two of the above varieties, which had hitherto been regarded as two distinct amorphous allotropes of sulphur, had the same crystalline structure as that of roll or rhombic sulphur, the stable crystalline form at ordinary temperatures. The result of a preliminary experiment with plastic sulphur was also reported.

Here we want to record, in brief, the results of further investigations regarding plastic sulphur and colloidal sulphur.

In the case of plastic sulphur only one diffraction ring corresponding to the spacing 3.6 Å approximately, has been obtained. This result agrees with what was obtained in the preliminary experiment reported in the previous letter. This type of sulphur, therefore, must be amorphous. The cellulose thread or a metal wire structure, observed in the case of a thread of plastic sulphur under tension, by J. J. Trillat and J. Forestier[2] may be due to the tendency of the strongly associated S-atoms towards some favoured orientation under the influence of the tension. That the plastic sulphur which may again be regarded as super-cooled liquid sulphur contains strongly associated S-atoms is clear from the fact that they are highly associated even in the vaporous state as is evident from its vapour density-values. In the plastic state the degree of association may be expected to be at least equal to, if not higher than, that at the boiling point. The vapour pressure at about this temperature corresponds to S_8.

With this idea the observation made by the above authors may be explained by comparing it with that made by other experimenters in the case of extended rubber which also shows a cellulose thread-like structure whereas ordinary rubber appears to be amorphous. In the case of plastic sulphur, the groups of strongly associated atoms may behave as polyatomic molecules of sulphur.

Colloidal sulphur has been tested in the state of solution in water. One diffuse ring has only been obtained and this corresponds to the spacing 3.22 Å. We can make no conclusive remark as to the origin of this ring at the present stage. For, water itself produces a ring having the spacing 3.24 Å nearly. However, if the ring be due to the collodial particles (which were approximately of diameters $0.5-1\times10^{-4}$ c.m.), they can possess no regular arrangement of atoms in them. Further work is in progress here to elucidate the point.

A deposit of colloidal sulphur made by adding NH_4OH to the solution has also been examined. Four diffraction rings were obtained, the outer two being very faint. The two inner rings correspond to the spacings, 3.6 Å and 3.0 Å approximately.

A sample of plastic sulphur which had been prepared three weeks before it was tested, has produced four rings corresponding to the spacings : 3.8 Å. 3.0 Å. 2.4 Å. and 2.2 Å approximately. These values, being in agreement with those of rhombic sulphur, support the idea that plastic sulphur transforms ultimately into the stable crystalline variety at ordinary temperatures.

Experiments are in progress to study some peculiarities of the above mentioned allotropes and to determine the structure of the remaining modifications of sulphur.

S. R. Das.
K. Ray.

Khaira Laboratory of Physics,
University College of Science.
92, Upper Circular Road, Calcutta.
July, 1936.

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1. SCIENCE & CULTURE, June, 1936.
2. *Comptes Rendus*, *192*, 559, 1931.

Curious Experience in Rat Breeding

During the last four years or so white or Albino mice have been bred in the Bose Research Institute with a view to determining the effect of different diets on the development of these animals. A few facts in connection with the breeding of mice observed during the course of this work may be recorded here.

The young mice usually produce their first litter when 108 to 120 days old, but in a few cases first litters were produced by mice which were only 91 days old. The normal period of gestation for the mice was observed to vary from 19 to 23 days.

The following case of a pair of mice is of special interest. The female of this pair produced its first litter on the 11th June 1936 ,when she was 118 days old. The litter consisted of 3 young, one of which died soon after birth, while the other two were suckled by the mother till the 7th of July, but after this date it would not even allow its young to go near her. The young were now separated from the mother and the next morning it was found that during the night the mother had given birth to a second litter consisting of two young. Apparently this is a case similar to those reported by Kirkham and is to be explained as an instance of a lengthened gestation period in mice which are pregnant during the suckling of the progeny of a previous litter. The delayed impregnation of the young of the second litter is apparently due to an inhibitition of some type exerted by the fully activated mammary glands upon the uterine mucosa. The fertilization, however, must apparently have taken place as a result of coitus before the birth of the first litter.

We are indebted to Dr. Baini Prasad, Director, Zoological Survey of India, for help in connection with the literature on the subject.

N. C. Nag.
H. N. Banerjee.
A. K. Pain.

Bose Research Institute Laboratories
Calcutta and Falta..
22nd July 1936.

We regret to announce the deaths of

Dr. F. J. S. Shaw, Director of the Institute of Agricultural Research;

Prof. K. K. Mathur A. R. S. M., Principal Science College and Head of the Department of Geology, Hindu University, Benares;

Dr. Panchanan Mitra, Head of the Department of Anthropology, Calcutta University.

In *Science and Culture*, 2, p. 50, col. 1. line 3
for 'hidden' *read* 'midden'.

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SCIENCE AND CULTURE

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Water Hyacinth

WITH the passing of the Bengal Water Hyacinth Act in May, 1936, a new chapter is closed in the interesting history of this handsome pest. Like many dangerous creatures, this pest has a graceful form and beautiful flowers which attracted the notice of men, and the plant insinuated itself into the good graces of flower-lovers who introduced it into this country. Like many other unwanted plants such as cacti and *croton sparsiflorus*, this one spread rapidly in its land of adoption till it became a great nuisance. Ponds and pools and stagnant streams and railway borrowpits became covered with water hyacinth and even cultivable and cultivated land was encroached upon. People gave up attempts at checking the spread.

In 1918 the Government of India issued a pamphlet emphasizing the necessity of eradicating this pest. In 1921 the Government of Bengal appointed a Committee under the chairmanship of Sir J. C. Bose to investigate into the various aspects of the problem and to suggest the possible methods of eradication of the pest. The Committee recommended :—

1. "That there is ample scope of detailed investigation into new methods of eradicating the Water Hyacinth and that until new methods have been thoroughly tested and the cost worked out, the mechanical methods of collecting by hand and burning or burying the weed was the most practical one for the conditions prevailing in Bengal.

2. "Whatever methods for eradicating the pest are eventually adopted it will be absolutely essential to insist on concerted action from all parties concerned. The weed spreads so rapidly that any person who fails to act at the same time as his neighbour will probably be responsible for undoing the work of eradication over the whole area, as the presence of Water Hyacinth on his individual holding would undoubtedly act as a centre for re-infection."

Attention thus focussed led many investigators to study the various aspects of the plant. Thus in Bengal Kenneth Maclean Finlow, Brühl and his co-workers studied the plant from various points of view, while R. L. Sethi published a comprehensive note in 1927 on this pest in the United Provinces.

Dr. H. K. Sen investigated the utilization of the water hyacinth for, and advocated, the production of alcohol, etc., from this weed. Against this people have argued that this will perpetuate the pest and slight carelessness will lead to unwelcome spreading of the dangerous weed.

Although legislation was recommended by the Water Hyacinth Committee it had not been resorted to so far. In the meanwhile the Government of Bihar and Orissa helped local bodies, especially in Orissa, to frame bye-laws for the eradication of this pest in that region. The District Board of Cuttack framed bye-laws (1923) which made ownership of land or water containing water hyacinth punishable with fine if it was not removed after notice had been served, but nothing tangible was effected.

In 1926 Sir Henry Wheeler visited Orissa and, alarmed by the extent to which the weed existed there, drew the attention of the District Officers to the seriousness of the problem. In 1927 Mr. N. F. Peck, I.C.S., who had at one time served in Bengal, carried a drive in the eradication of this pest in the district of Cuttack. His energy and enthusiasm cleared the district of Cuttack of this pest and other districts followed his example. An excellent account is given in his book published in 1930.

This showed what organized effort could do, but the difficulty of the task was soon realized when the weed appeared again in carefully cleared tanks.

So far it had been thought that the plant multiplies vegetatively and although it produced seeds they did not play any important part in its spread. Obsessed with this idea the officers in charge of clearing operations were mystified and took the help of a botanist (P. Parija of Ravenshaw College, Cuttack) to unravel the mystery. Parija found that seedlings played a very important part in spreading and repopulating stretches of water in Orissa. This was confirmed in Burma by Robertson and Ba Thein. The Imperial Council of Agricultural Research financed a scheme of research in Orissa, which emphasized the importance of seedlings in clearing operations and the need for vigilance year after year as the seeds retain their viability for several years running.

One defect in Orissa operations was that reliance was placed on bye-laws of local bodies. So long as there are enthusiastic officers like Mr. Peck, the bye-laws operate well. Even then the local bodies are slow to prosecute. It is therefore inevitable that as soon as pressure is relaxed local bodies become slack and the stretches of water are repopulated with water hyacinth, as is the case in Orissa from all accounts.

This danger is removed by the Bengal Act which empowers any authorized officer to take initiative and effect clearance in a notified area if the owner fails to do so after due notice.

What is necessary is to impress on the officers and the public the necessity for vigilance, as the danger from lurking seeds is there. We can do no better than quote from Parija's article in *Agriculture and Live Stock in India* (Vol. V, pp. 1-2, 1935).

"One must be vigilant from year to year, as the weed is likely to appear from seeds which have been lying at the bottom of tanks. It has been found that seeds may be dormant for several years, at least seven years, without losing their vitality, when, in any year of drought, the tank dries up, and the seeds germinate after the first shower of rain. The seedlings grow rapidly with the rise in level of water up to a limit and then they get submerged. In a day or two the seedlings break off the root-stock neatly and float up. Near the clean surface of breakage new adventitious roots come out and the plants are established as floating organisms.

"If the tanks are to be kept free from water hyacinth they must be cleared from year to year till the dormant seeds are exhausted. The question is as to the time of the year at which clearing must be done.

"The most suitable time will be suggested from the facts of seed production and germination which are given below. The water hyacinth flowers almost throughout the year. Flowers are particularly abundant during the rains and the spring. When the flowers wither, the spike bends down in the form of an inverted S and often its tip dips into water.

"Although careful search has been made in these plants for fertile capsules in spring and early rains, no capsules have been found. Fertile capsules appear only towards the end of October and November. The temperature at this time seems to be suitable for seed formation. These capsules burst when mature and discharge the seeds into water. The seeds are heavier than water and sink to the bottom of the tank or pool and lie dormant there. If in summer the bottom of the pool dries up, the seeds lying there sprout after a shower of rain. It will thus be seen that the danger from seeds can only arise in autumn when the fruits mature. If clearing can be done in August and September, the flowers cannot get a chance to set seeds and the danger of re-infection from that source can be avoided.

"One may be tempted to clear the seedlings early in the rains, but the difficulty is rather great. First of all, the seedlings are likely to be mistaken for grass for one or two months from sprouting. Secondly, even when they float up after submersion, they may lurk among other water weeds and make the search difficult and tedious. All this can be got over if clearing is done after the plants attain maturity and before they set seed.

"Another way of checking seedlings is to keep the tanks, etc., full of water throughout the year, but that is not practicable.

"As to the method of clearing, there seems to be only one sure method and that is mechanical. Chemical spraying in order to be effective must consist of strong chemicals and these introduce other complications like killing water animals and making the water poisonous for cattle. Mild sprayings only check the growth. Mechanical clearing should be thorough and care must be taken to ensure killing the plants thus collected. Otherwise a chance root-stock left alive is capable of repopulating the whole stretch of water in one or two years. This plant has remarkable power to adapt itself to life in dry situations as well as in free water. A root-stock thrown in mud will strike roots and as the mud dries, the plant adjusts itself to a land life and waits for the chance of getting into water when it comes. Although attempts at clearing have been repeatedly made, despairing failures have resulted from the presence of seeds in the mud and also from neglected living root-stocks. The clearing operations in Orissa had the merit of being very thorough. The authorities were aided by District Board by-laws and negligent owners of tanks and pools were prosecuted."

Given proper care and zeal, what has been possible in Orissa is surely possible in Bengal.

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Fish and Fisheries of Bengal

B Prashad

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At the very beginning, I should like to direct your attention to the very great importance of the fish and fisheries in this province. The careful enquiries of the late Sir K. G. Gupta, who was placed on special duty by the Government of Bengal in 1906 for carrying out detailed fishery investigations in the province, showed that no less than 80 per cent of the population of Bengal eat fish. He remarked that while most people do not eat fish every day and though at certain times of the year fish is taboo for at least the higher class Hindus of Bengal, it may safely be estimated that on at least 320 days in the year fish forms an important part of the diet of the fish-eating population of the province. Allowing about 2 chittacks or 4 ounces per head per day, the quantity per head per annum comes to about one maund. The population of Bengal in the last Census was estimated at a little over fifty millions and, therefore, for the annual consumption of the fish-eating population of the province a supply of about forty million maunds of fish is required. I need hardly add that for the Bengalees, whose staple grain diet consists of rice and most of whom do not take any meat, the importance of fish for the necessary proteins in the daily diet cannot be overestimated. For the supply of this enormous quantity of fish Bengal is mainly dependent on its inland fisheries, amongst which I also include the estuarine fisheries in the Gangetic Delta. Vast as this area is, it is difficult to estimate accurately its exact extent, but Mr. Southwell, who was the Director of Fisheries of Bengal, Bihar & Orissa for many years, roughly estimated the potential fishery area of Bengal at somewhere between 7,000-8,000 sq. miles in the dry season. During the rains, however, when almost two-thirds of the country are under water the extent of this area would become very much greater. In spite of its vast extent, the fish supply of the province, as various authorities like the late Sir K. G. Gupta, Mr. Southwell and others have pointed out, is inadequate and the prices ruling for the fish available are very high, they are certainly beyond the purchasing power of the poorer classes. To make this point clearer we may consider the case of Calcutta a little more closely. The total population of Calcutta in 1913 was roughly 900,000 and the imports of fish into Calcutta along rivers and canals during the year ending March 31st, 1931, amounted to 48,325 maunds, while imports *via* railways during the same period amounted to 144,039 maunds. The total imports of fish, therefore, were 192,364 maunds. The average supply of fish available per annum per head of the population was, therefore, roughly 10 seers, or about 1/4th of the actual requirements of the fish-eating population, basing the calculation on the consumption of 2 chittacks per head per day. According to the latest Census Report, the population of Calcutta proper has increased to 1,196,734. The fish supply of Calcutta has certainly not increased correspondingly, and whatever increase there may have been is more than fully counter-balanced by the fact that a fair percentage of the fish brought into Calcutta is not for consumption in Calcutta alone, but is re-exported from here to other parts of the country—Calcutta, as we all know, is not only a receiving but a very important distributing centre for fish, as indeed for all commodities.

I casually mentioned above that Bengal has to depend on its inland fisheries for the major part of its fish supply. This is due to various causes, but two of these seem to be the most important. One is the fact that marine fisheries in the Bay of Bengal are neglected and no fishing worth the name is carried out anywhere in this very rich area, while the other is the inherent prejudice on the part of the fish-eating public of Bengal, leaving aside the Europeans and others who are particularly fond of sea fish, to sea fish of any kind. The Bengalees particularly favour freshwater carps, amongst which one may enumerate *Catla, Rohu, Mrigal, and Calbaus*, while smaller scaled fishes, scale-less Siluroids like *Magur*, *Singhi*, and such forms as are generally included in that comprehensive name "Jeol Machh" or fish which can be transported alive and sold as such to the consumer, form the fish diet of the poorer classes. Unfortunately, the supply of these is not sufficient and the peculiar conditions in the province in reference to the rights of fishing in the rivers, lakes, *jhils*, etc., as a result of the Permanent Settlement and vested rights, make it a matter of some difficulty for improving the condition of these fisheries. Another factor of very great importance, which makes it almost impossible for these inland fisheries to flourish, is that fishing is carried on all over the province in the so-called good old way. This chiefly consists in intensive fishing in small areas and, as would be apparent, such type of fishing is most destructive not only to the fishes and fisheries but to the interests of the fishermen themselves. No attention whatever is paid to the conservation of these fisheries, and as a result they become more and more impoverished every year.

As the question of the conservation and improvement of the fisheries in this province is intimately bound up with the causes of their impoverishment and deterioration, it would be useful at this stage to consider some of these factors. The inland fisheries of the province, leaving aside the estuarine fisheries, consist mainly of river fisheries, fisheries in canals, *jhils or bhils*, tanks and ponds, and, during the rainy season, in the paddy fields.

The conditions in the river and canal fisheries are almost similar, though naturally the rivers offer a better *milieu* and more protection to the fishes than the canals which are cleaned out almost every year and where, in the majority of cases, permanent fisheries cannot exist. In the rivers also the conditions are not very stable. The effects of silting, too much steamer traffic, weirs and bunds, establishment of large factories, steeping of jute and similar substances, and the use of rivers for the drainage of the sewerage of big cities, which pollute the water to a great extent, are often responsible for impoverishing flourishing fisheries in such waters. Most rivers of Bengal, at least the lower reaches, are further affected by tides, as a result of which the salinity of the water is greatly increased, particularly during the long dry season. At such times these lower reaches are not by any means suitable for the freshwater fishes.

The fisheries in the *jhils* and *bhils* are undoubtedly of very great importance. They are excellent breeding grounds for a variety of marketable fishes, and there is reason to believe that even the carps such as *Rohu*, *Catla*, etc., which in India do not normally breed in confined waters of ponds and tanks do breed in these extensive areas. Unfortunately, however, though these *bhils* could develop into most productive fisheries, they are so indiscriminately fished from year to year that their fish population has no chance of recouperation, and so the fisheries become more and more depopulated every year. During the dry season the area of these *jhils* is greatly reduced and the dry land along the banks and even in the beds is often used for cultivation. Further, numbers of these areas are being gradually reclaimed for purposes of cultivation, and as a result they are not so extensive today as they were 50 years back.

The tank and pond fisheries in Bengal are also very important, as in the case of these fisheries only some attempt is made towards artificially increasing the fish supply of the province. Most of you must have seen fishermen carrying young fry in earthen *chatties* slung over their shoulders during the rains. Every one of these *chatties* contains several thousands of young fry, mostly of carps but also of predaceous fishes, collected by fine-meshed nets from rivers. This fry is sold in the market for stocking tanks and such areas, but unfortunately this primitive type of fish or carp culture is not so productive of results as one would hope it to be. The entire activities of the carp-culturists in Bengal are confined to the purchase of the fry, which is often in its very early stages of development, and later to introduce it into one of their tanks. In Europe and America, on the other hand, the fry used for pisciculture, is always pure and is in the beginning carefully nourished and tended in nursery tanks which have been freed of all predatory fish and other enemies of young fish. Only after the young fishes have grown to at least the fingerling stage, they are introduced into areas which are to be stocked with fish. Such areas also are first netted and cleared of all predaceous fishes and other enemies of young fish. As a result the young fingerlings introduced in such areas find excellent conditions for their growth into adult fish within a reasonable time. The question of their food supply is also not neglected, and the fish-culturists and stockists reap a very rich harvest as a result of their efforts. In Bengal, on the other hand, the young fry are introduced into tanks, etc., full of predaceous fishes and other enemies of the young fry, and it is very lucky indeed, if even 5-10 per cent of the fry introduced grow up into adult fish.

The paddy-field fisheries, are not of sufficient importance to be discussed seperately here.

It will thus be apparent that in addition to the reduction in the extent of the fishery areas the causes of the deterioration of the fisheries in the province are (1) indiscriminate and uncontrolled over-fishing, (2) no close season (I did not refer to this point earlier, but in Bengal, as indeed all over India, as a result of there being no close fishery season, at least for the indigenous fishes, a very large number of breeding fish are caught and destroyed during the breeding season which, as with all animals, is the most critical period of their life. This naturally reduces the chances for the repopulation of the fisheries, for the number of the breeding individuals is gradually reduced), (3) the deterioration in the condition of the fishery areas themselves, and (4) absence of properly organized methods for the over-fished and depopulated fisheries.

We may now consider briefly the means of transport and distribution of the catches in the country. A great deal of fish is taken to Calcutta and other centres of distribution from long distances in baskets, often without any ice or any other such agency which would prevent putrefaction setting in. Even where the fish are sent packed in ice, the primitive methods employed make it impossible in most cases for the fish to reach the consumer in a condition fit for human consumption. Within recent years refrigerating vans have been provided by some of the railways, but as a large percentage of the fish imported into Calcutta is brought in boats along rivers and canals, such facilities as refrigerating vans on the railways have proved of little use. Even in the case of the fish brought into Calcutta by railways a great deal of it comes from areas where such vans are not available, and, in any case, as the fish is only put into the vans long after it has been caught, it is often already tainted, and later transport in refrigerating vans is, therefore, of little value.

We may also make a passing reference to the peculiar trade conditions in regard to fishes in Bengal. A very powerful ring of tradesmen controls the marketing and sale of the catches mostly in Calcutta, but its nets are widespread throughout the province. These tradesmen have a very strong hold over the fishermen, as a result of which it is impossible for the poor folk to realize anything like a living wage for their hard labour, while the cost of the fish to the public, owing to the monopoly enjoyed by this ring, is very high.

So far I have not referred to the estuarine fish or fisheries, but it would be impossible to consider them in any detail during the time at my disposal. I may, however, mention that the estuarine fisheries of the province are probably the most extensive and the richest of any known. The lower reaches of the Gangetic Delta, with the extensive streams and creeks in the area, offer the most favourable *milieu* for a very large variety of excellent food fishes. The food supply for the fish in this region is very abundant and the biological conditions in general are extremely favourable. The resources in this area are, however, exploited so extensively that the harm done to the fisheries is, in many cases, incalculable. Among the edible fish of this region I may mention the *Bhetki*, whose range is co-extensive with the range to which the rivers and streams are affected by tidal influence: the Bombay Duck, the Mango-fish, and various forms of Flat-fishes, Cat-fishes, etc. It is also this region which has become almost a permanent home for our famous fish, *Hilsa*. This fish, at least in the Gangetic Delta, differs from other anadromous fishes which only ascend into the fresh waters for breeding purposes after the rivers are flooded as a result of the very heavy rains. It appears to have become a more or less permanent denizen of the Gangetic Delta. In addition, the estuarine areas are particularly rich in prawns and crabs, but it is impossible for me to deal with these today. I may, however, conclude by saying that the fisheries of this area are a source of great potential wealth, and if they are exploited on properly organized lines, they are sure to increase materially the fish supply of the province and yield an ample return on any capital outlay.

The problems of the fisheries of the province are very intricate, and unfortunately our information in regard to the fishes of Bengal, their growth, their friends and foes, their life-histories and habits, the biological conditions under which they live, as also the extent of the fisheries, is very inadequate. Such research work can only be carried out by a properly organized and equipped scientific department, and it is very unfortunate that owing to financial stringency the Fisheries Department of the province was abolished about 1922; since that date no scientific department has carried out these duties, though a great deal of scientific work on the fishes of India is being done by the Zoological Survey of India. There are, however, other problems in reference to the socio-economic work, such as the organization of the trade, and improvement in the methods of transport and marketing, as also the condition of the fishermen of the province, for which the general public can do much more than any Government department. Let us hope that these aspects will attract the attention of some public bodies and individuals in Bengal.

Finally I may conclude in the words of the late Surgeon-General Francis Day, who for many years as the Inspector-General of Fisheries in India and who in his introductory note to *A Statistical Account of Bengal*, stated as follows: "Without entering more fully into this subject, it may be fairly advanced that fish is more suitable as a general food to the natives of the Indian Empire than the flesh of village sheep, pigs, and fowls, whilst the majority of the people eat it when they can procure it. Where no regulations exist as to the method in which fisheries should be worked, and should other circumstances be equal, that country or district which is most populated by man will be the most denuded of fish. Individuals would sooner live by fishing than by agriculture, as the trouble of capturing the finny tribes is less than by tilling the soil, being simply catching without any idea of preservation. Naturally, fish have been endowed with certain means of increase, and protection, such as producing an enormous number of eggs or frequent breeding, or even by the action of periodic floods, when small-meshed nets cannot be used in rapid streams (this amount of protection does not extend to any great extent to the fry of fishes, as they would be washed away by a rapid current, consequently they seek the shallows), and by swamps covering a large extent of country, where shelter is afforded by grass, rushes, etc, rendering vain man's attempt to depopulate. But, as inhabitants augment, watery wastes become drained and cultivated, predatory man increases his methods of destruction, and then a decrease of food becomes apparent. As the price of food rises, so that of fish increases, and if the fish-eating population yearly becomes larger, increased exertions are used to capture fish to meet their demands: the size of mesh is decreased, weirs are augmented, and everything taken, no matter how small, as fishermen never appear to consider from whence the next year's supply is to come, but only the easiest method to take at the present time all they are able." All this is as true today of Bengal as it was when Day wrote it in the early eighties of the last century.*

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* A résumé of a lecture delivered before the Rotary Club, Calcutta, on Tuesday, the 28th July 1936.

On Particle and Wave Nature of Matter and the Complementarity of the two Aspects—

Being a Conversation between a Classical Physicist and a Quantum Theorist

CLASSICAL PHYSICIST: Mr. QUANTUM THEORIST! You are so fond of talking always about *Duality*, *Uncertainty*, Ψ, Φ, and so on. Can you tell me in plain words what is really new in these things? Do you not see that Duality is everywhere? Take the two *faces* of *a coin*, the two sides of a shield, and so on. What wonder is there if photons and electrons also show a dual nature, *particles at times and waves at other times*?

QUANTUM THEORIST: You will excuse me if I talk a bit of philosophy. How do you know, Mr. C. P., that a coin has two faces? I only see one face at a time. It may be that it is the same face which at times shows a head and at other times (perhaps miraculously) changes into a tail. How do you refute me?

CLASSICAL PHYSICIST: Well, I show you both the faces at the same time. Put a mirror behind and you see the two faces *simultaneously—the dual aspect seen together*.

QUANTUM THEORIST: You have hit at the crucial point; and it is that you can arrange an experiment where you can see the dual aspect of a coin, a shield, etc., at the same time; and also one can so arrange that the one aspect gradually and continuously passes into the other aspect. Having seen the two aspects together one can easily construct a picture of the whole entity. But what will happen when the entity is such that, with all the ingenuity one can command, one cannot arrange an experiment which will show us its two aspects at the same time. Imagine a coin, call it X, for which we can see one face at a time but *under no circumstances* its two faces at the same time.

CLASSICAL PHYSICIST: You seem to be talking nonsense. If a man has commonsense, and he will be no classical physicist if he has not that, he would refuse to imagine such fantastic things.

QUANTUM THEORIST: I wonder if the classical physicist has much of commonsense. He has only a naive faith. As for commonsense it has never been his strong point. Fancy your very first law of motion asserting that a particle unacted by force moves in a straight line with uniform velocity. Now, if I ask you to draw an exact straight line you yourself will agree that it will be an impossible task. Make your best efforts and yet the line will always show some unevenness, probably not to the naked eye but under a microscope. You cannot draw a perfect straight line with all your instruments and twentieth-century experimental technique, and yet you believe that an insignificant and inanimate tiny particle can perform this miracle. If it is not faith, I wonder what it is! But I have digressed from the main point.

I was asking you to imagine a coin which possesses the strange property that we can see only its one a face at time and find it impossible to devise any means whereby we could see both the faces simultaneously. Such a coin, fortunately, never exists. If it ever existed we shall soon say it was a ghost, for we could never form a *picture* of a coin with such ghost-like properties. No one will say it was a coin. All will say it was a ghost.

CLASSICAL PHYSICIST: But what has Quantum theory to do with such ghost-like coins?

QUANTUM THEORIST: If there was no connection between the two I should hardly talk of it. But I shall narrate you a short story before I disclose their relation to Quantum theory. The story is about one Mr. H, who lives in *Quantumland*—the 'land' discovered by Bohr, Heisenberg, Dirac, and others.

CLASSICAL PHYSICIST: Oh yes! I have heard of Quantumland. It is quite a fashionable land these days. Most of the modern physicists have their head-quarters there.

QUANTUM THEORIST: If you are interested, I can tell you something more about this land and its recent developments. Planck was the first who entered this land, but Einstein and Bohr soon joined him. Bohr has done most in making this land fertile. Most of it at present is being cultivated by his disciples—he adding from time to time new fertilizers, but the yield as yet is not enough to satisfy all the demands.* You must have heard that Eddington has built there a sky-scraper of 136 stories, and later added one more to make the total 137. Dirac has proved that his house is spinning, but you cannot *observe* the spin. The most popular game in that land is that of "billiards" and Rutherford has ever been the champion. The game is very different from ordinary billiards and Rutherford and his co-players are continually finding new kinds of balls to play the game. You can easily recognize the houses of de Broglie and Schrödinger by their wavelike structure. Heisenberg has a castle closed on all sides and having no windows or even doors—it is a wonder how he himself gets in and out. If we believe Gamow, then he does this by 'leaking' through the solid walls. At one time Compton was the minister for justice—and he was a merciful judge. He punished quanta according to their size. For the same offence a bigger quantum was meted out more punishment than a smaller one. Raman is the present incumbent of this office—he punishes quanta to the same extent no matter whether the quantum is big or small.* The Surgeon-General is Saha. He has discovered a 'thermal' knife to operate upon atoms—the electrons in atoms can be most successfully amputated with this knife. He has shown us a method of diagnosing the condition of atoms in distant cosmic worlds, and astrophysicists the world over now use his method. And there are one or two most distinguished visitors from other lands, *e.g.*, Milne from Cosmic land.

But let me now resume the story about Mr. H.

It has been found that whenever Mr. H has gone into a fruit garden in his native land some fruits have always disappeared. You will conclude that he is a thief, but if you are a conscientious person, you will for a while hesitate to draw that conclusion and ask the police to investigate the matter and catch the fellow redhanded, *i. e.*, actually stealing the fruits. The police did investigate the matter: policemen hid themselves behind the trees and kept a secret watch on H. They used all the ingenuity of Scotland Yard to keep a watch as secret as possible so that H could not have the faintest clue that any policemen were keeping a watch on him. No fruits were stolen during this period, though the police saw H several times going in and out of the garden. They then retired and reported that H was not a thief. But after the police retired the old trouble started again—whenever H entered the garden, fruits always disappeared. Now I ask you, Mr. C. P., what will you call him—a thief or an honest person ?

CLASSICAL PHYSICIST: Mr. Q. T., from what you say I suspect that the fellow is not honest but somehow he succeeded in evading the police; possibly the police did not utilize all their resources in tracking him down.

QUANTUM THEORIST: Take it as certain that the police spared no pains in this investigation. They used all their resources—photo-cells, wireless apparatus, infra red light, and so on, and took the help of all the physicists, chemists, engineers, and so on, yet on no account they found H in the actual act of stealing the fruits.

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* A conference on atomic physics was held at Copenhagen on June 17-20 this year at Prof. Bohr's Institute for theoretical physics. About eighty physicists attended the discussions. A brief report has appeared in *Nature* of July 4th, 1936, from which the following extract is taken :

"The course of the discussion was, as always, directed by the masterly fundamental criticisms of Bohr. On these occasions, when so many able theorists are gathered together, it is clear that Bohr's physical insight is the power, which contributes most to the advances of theoretical atomic physics, and creates the conditions which fertilize the mathematical abilities of theoretical workers elsewhere.........."

The general impression left by the conference was that progress in experimental research on the atomic nucleus is very rapid, but that the advance in the theoretical description of the new results is much slower."

* In Compton effect the energy decrease of the incident quantum i.e. the difference between the energies of the incident and the scattered quanta is proportional to the energy of the incident quantum. In Raman effect, on the other hand, this energy difference is independent of the energy of the incident quantum.

Classical Physicist: I still suspect H to be a thief; only he seems to be cleverer than all the police and may be using some kind of secret rays (not known to the police) to know the presence of politemen watching his movement.

Quantum Theorist: Dear C. P.! what you are saying now does not do you justice as a physicist. A physicist, as you yourself have so often said, is not entitled to form opinions which are not ultimately warranted by observations and experiments. In the case of H one set of facts (police reports) show that he is honest; the other set of facts (report of the gardener) show him to be a thief, and as a physicist I see no reason why you should be prejudiced and give more weight to one set of facts than to the other.

Classical Physicist: This seems a bit puzzling. I will say that the fellow is no ordinary person.

Quantum Theorist: The actual facts about H are that he is sometimes a thief and sometimes honest, and so let us call him a thief-honest man. We cannot understand such a strange character, because it is one which is not met with in our ordinary experience. He is a "non-classical man," and therefore his behaviour cannot be comprehended on classical ideas. I now come to the relationship of these examples with the fundamental principles of Quantum Mechanics.

An electron or a photon, or as a matter of that any particle, has a dual nature; it sometimes behaves as a particle and sometimes as a wave, and the most fundamental point is that we can think of no possible experiment wherein the particle aspect and the wave aspect can both be seen at the same time. That precludes us from forming a mental picture or a model of electron, photon, etc. Just as with our ordinary human ideas we could not understand the behaviour of H in our second example, or could from the picture of the coin in the first example, similarly with classical concepts it is impossible to understand the nature of electrons, etc. We must emphasize once again that the cause of this impossibility is not the dual nature of the entities (electrons, photons, etc.) but this *complementarity of the particle and the wave aspects, i. e., the two aspects can never be seen at the same time.* If the two aspects could be demonstrated at the same time, then it would be possible for Classical Physics to form a picture of these entities on classical lines. Classical Physics fails to explain the behaviour of these entities because of the complementarity of these two aspects. As Dirac has remarked, the basic concepts of Quantum Physics can no longer be expressed in familiar language or in terms of words at all. "Nature works on a different plan. Her laws do not govern the world in any direct way, instead they control a sub-stratum of which we cannot form a mental picture without introducing irrelevancies." It is only by mathematical symbols that one can express, or better describe, the workings of Nature. As Jeans has said, "God seems to be a pure mathematician."

Next time when we meet again we shall invite a pure mathematician also at our conversation.

Classical Physicist: In my younger days I used to picture the electron as a Roman soldier. You can look straight into his face and he remains unperturbed. My habit of forming mental pictures of everything, I am afraid, still continues and now I may perhaps picture the electron as a tiny bird. You look at it, and when you want to locate its distance from you, you throw a measuring tape, the distance is known, but lo! the bird is frightened and flies away and its velocity becomes unknown—Heisenberg's uncertainty principle, when the position is exactly known the velocity is completely unknown and when the velocity is exactly known the position is completely unknown. We cannot observe an electron without perturbing it and, as you have said, it is impossible to enquire closely as to how this disturbance arises or to know its exact amount.

D. S. K.

The Mystery of Cosmic Radiation

A. K Das

Upper Air Observatory, Agra.

[The public is now well informed through the daily press of the phenomena of cosmic ray. Scientific men working in widely different parts of the world have discovered a mysterious radiation which coming from space is constantly bombarding our atmosphere. Up to this time it has not been found possible to identify these radiations with any rays known on earth. The interest created is so great that world-wide surveys of rays have been undertaken by the Carnegie Institution of Washington and many other national parties. For anything we know, these rays may be responsible for starting great changes in the world. In fact some scientists have seriously proposed with the aid of cosmic rays to reconcile the Darwin's theory of evolution of species with the Mendellian law in genetics. According to Darwin, plants and animals are evolving from lower types throughout geological ages to newer species. This is opposed to our knowledge of genetics. As in our laboratory it has not been possible to create new species from existing ones, so the hypothesis has been advanced that probably cosmic rays may by chance affect the chromosomes or genes and produce new species. Some support is given to this hypothesis by Müller's discovery that X-rays cause nuclear changes causing mutations, that is, producing some fundamental change in the type.

In the following series of essays Dr. A. K. Das, Asst. Meteorologist, who has worked on this subject in the Cambridge Solar Observatory, gives a connected history of the discovery of this phenomenon and of the scientific work which has been carried out in different parts of the world.—Ed. S & C.]

PART I

THE history of scientific progress teaches us that almost all great discoveries have their beginning in some seemingly unimportant observations which do not fit in with accepted facts. This is true also of "cosmic radiation". In 1901, much work was being done on the electrical conductivity of air. Air, if it be perfectly dry and dust-free, does not conduct electricity at all. But when it is subjected to X-rays ultraviolet light, radioactive bodies, air acquire considerable power of conducting electricity.

In 1901, those early pioneers, Elster and Geitel, whose works form the starting point of many important lines of work in physics, made the interesting observation that the air in cellars and caves was a very much better conductor of electricity than the open air in the normal state, and that air which had been drawn from the earth by sinking a tube in the ground conducted some twenty times better than ordinary air. This and other observations of a similar nature gave rise to the belief that the elements present in the earth's crust contained traces of radioactive matter which sent out rays (α, β and γ) which diffused into the air of the neighbourhood and imparted abnormal electrical conductivity to it; the slight conductivity normally found in open air was also believed to be due to the presence of a radioactive gas. Soon after Elster and Geitel's observation was published, Rutherford and Cooke and also MacLennan working independently found that the conductivity of air enclosed in a hermetically sealed brass vessel could be considerably reduced by shielding the vessel with a metal cover or by immersing it in water. It was apparent therefore that the normal conductivity of air in closed spaces could not be entirely due to its emanation content, but must be produced partly at least by *an action originating from an external source.* This external source was at first naturally thought to be the radioactive elements emitting highly penetrating γ-rays, and in support of this conclusion was the observation of Cooke who had found that the conductivity of air enclosed in a sealed vessel could be reduced to 70% of its original value by a lead shield 5 cm. thick, but further increases in the thickness of the shield were without effect on the conductivity. In fact, it was recognized that air, especially freed from radioactive bodies and enclosed in a sealed vessel, acquired an appreciable conductivity which could be explained only by the action of γ-radiation from the environment, for in those days no more penetrating radiation was known than the γ-rays from radioactive elements. However unexciting this conclusion may appear to be, it was nevertheless the starting point of a whole series of researches which finally led to the discovery of the most mysterious radiation known to physics, —the so-called "Cosmic Rays" which form today one of the most fascinating and fundamental branches of research engaging the attention of physicists, astronomers, and geophysicists alike.

The γ-rays, which in the early years of the present century were believed to be entirely responsible for the ionization of purified air enclosed in air-tight thick-walled vessels, can originate principally from the radioactive elements present in the earth and to a comparatively small extent from the radioactive emanations and their disintegration products present in the atmosphere. The penetrating γ-radiation from the earth is sometimes called *earth-radiation* and that from the atmosphere is called *atmospheric radiation*. The very numerous measurements made on the radioactivity of the soil and of the natural waters show that on the average the meterial of the solid earth contains 7×10^{-6} grams of uranium, 2.3×10^{-12} grams of radium, and 1.4×10^{5} grams of thorium per cubic centimetre, while the water of the sea and the rivers contains 2×10^{-15} grams/cm^3 of radium and 10^{-8} to 10^{-7} grams /cm^3 of thorium. Some springs and rivers fed by them no doubt have a comparatively high content in radioactive matter but they play no significant part in the phenomena of atmospheric electricity. But the air enclosed in the cracks and hollows of the earth is rich in emanation content, the amount of RaEm being on the average 2×10^{-13} Curie/cm^3; this air diffuses into the open air to a greater or less extent depending on weather conditions and increases the radioactive content of the free air which is normally about 2,000 times poorer in emanation. Now the radioactive elements present in the solid earth ionize the air principally through γ-rays, while the radioactive substances of the atmosphere owe their ionizing power almost entirely to α- and β-rays which they emit. Thus the role of the radioactive substances of the atmosphere in the ionization of gases enclosed in sealed thick-walled vessels must be insignificant compared to that of the radioactive constituents of the earth. This circumstance should make it possible to determine experimentally the intensity of the *earth-radiation* and the 'zero' of the ionization chamber, provided one could be sure that there is no other source of penetrating radiation than the earth and the atmosphere. All that would be necessary for the purpose would be to take the apparatus out into the open sea or to place it inside a sufficiently thick shield of absorbing material so that the *earth-radiation* is completely eliminated. In practice, however, the apparatus has to be shielded against extra-terrestrial penetrating radiation in order to find the 'zero' of the apparatus.

The Balloon Ascent Observations

If earth-radiation were the principal ionizing agent of the air under normal circumstances, one would expect its intensity to decrease with elevation in the atmosphere. In fact, calculation shews that at 50 m. above the ground itshould decrease to 49%, at 83 m. to 33 %, at 167 m. to 15 % and at 333 m. to 3. 7 % of its value at the ground level. But measurements carried out in 1910 and 1911 by Gockel in balloon ascents by means of sealed ionization chambers indicated that thei onization *increased* rather than decreased with elevation. This striking phenomenon was conclusively demonstrated soon after by V. Hess, who made ten balloon ascents and used more reliable apparatus than Gockel had at his disposal. In order to explain this phenomenon, Hess postulated the existence of some kind of *ultra-penetrating radiation* coming from outer space which he called "Ultra-rdiation" (*Ultrastrahlung*) and which the German scientific press alternatively named *"Hess'sche Strahlung"*. The now current names, *viz.*, *"Hœhenstrahlung"* in Germany and *"Cosmic Radiation"* in the English-speaking countries were later introduced into scientific literature by W. Kolhörster and R. A. Millikan—two of the most outstanding investigators of the nature and properties of this mysterious radiation. The intensity of the cosmic rays is measured by the number of ions which they produce in cm^3 of normal air per second. This amounts to 1.9 on the sea-level but Hess who carried out his balloon ascents up to a height of 4 to 5 kilometers found that the intensity becomes 10 times as great. At first it was thought that the sun might be the source of these radiations but balloon ascents, during a total solar eclipse and by night, showed that intensity of these radiations had nothing to do with the sun. They must be therefore coming from space.

Pilot Balloon Observations

Hess's discovery showed that in order to gain more knowledge of cosmic radiation observation has to be carried to much greater heights than can be reached by ordinary manned balloons. Above a height of 6-7 kilometers there is not enough air in the atmosphere to sustain human life, hence man's flight was out of the question; so the method of observations with pilot balloon was perfected by Kohlhörster and Regener in Germany and by Millikan and his coworkers in America. In these a balloon provided with an automatic registering apparatus is allowed to rise up in the atmosphere. The automatic apparatus is a height and temperature recorder and a closed electrometer which counts the number of ions and records them on a drum. It was found by these observers that the intensity goes on increasing exponentially with the height and when the air pressure falls to 40m of mercury which corresponds to a height of 28 kilometers the intensity rises to 300 ions per cm^3. This is about 150 times the intensity at a sea level. There are indications that after this height is reached the intensity remains constant.

Stratosphere Flights

In 1931, Picard in Belgium made his famous stratosphere ascents. A huge hydrogen balloon carrying a spherical gondola of diameter 7 ft. was allowed to rise in the atmosphere. The gondola was fitted with automatic recording apparatus and the observers sealed themselves in it. For breathing, oxygen was carried in cylinders. The cosmic-ray outfit consisted of a sensitive apparatus called Geiger-Müller counter. Whenever a cosmic ray hit the apparatus a sound was produced on the telephones. Picard records that at great heights the ticks of the telephone were so frequent and loud as to be almost deafening. Since the pioneer flight of Picard several others stratosphere flights have been carried out by Picard and his assistants, by Scientific Commission of the Soviet Republic, and by the National Geographic Society of America. These in general have confirmed the results obtained by Kohlhörster and others. Mention may be made in this connection of the ingenious experiments of S. Vernoff (1935), in which one had not to wait for the sounding balloon carrying the tube-counters to fall down to earth, but the counters automatically transmitted radiosignals giving the number of cosmic-ray coincidences at different heights. The results obtained are perhaps not so trustworthy as those of Regener, but they are in fair agreement with the latter and the method may, after improvement, prove to be of great value for the investigation of cosmic radiation in the upper atmosphere over thinly populated regions of the earth.

Investigations Below Sea Level

The number of cosmic rays decrease from 300 at 8 kms. to 2 at sea-level. The loss is due to absorption by the atmosphere on the way. As our knowledge of rays depends largely on their penetrating power the question arises whether the cosmic rays contain some constituent which may proceed even below sea-level. For this purpose Regener carried out a series of experiments in Lake Constance. A counter was sunk to a depth of 450 meters inside the lake. It was found that even at this depth cosmic rays had not entirely disappeared. From the experiments it appeared that if these rays were electromagnetic waves they contained constituents of extreme hardness[1], in facts about 1,000 times harder than the hardest rays known on earth.

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[1] The hardness of electromagnetic radiation can be expressed either with the aid of wave-length or with the aid of the energy content of each individual quantum. X-rays have generally the wave-length of about 10^{-8} cms. on I. A°. U. The energy content of a quantum of light of wave-length I. A°. U. is 12,000 volts. But X-rays have about 100 times more energy. The hardest γ-ray obtained from ThC'' has an energy of 2·6 million volts. But cosmic ray which can pass the atmosphere and 240 meter of water has an energy of 10,000 million volts.

Meteors

(Continued from the last issue)

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As it is, only the most massive or the most slowly moving meteors descend to the Earth's surface as meteorites. The fall of about 6 to 8 meteorites is recorded annually ; but this does not represent the total number that actually fall on the Earth, three-quarters of whose surface are covered by water and only a poor fraction of land is inhabited by, or accessible to, man. Taking all this into consideration, the total number of meteorites that reach the Earth's surface annually may safely be estimated at four to six hundred.

The chemical composition of most of the typical meteorites is fairly accurately known. About 30 elements have been identified. While there is no element in this list that is new or outside the chemists' Periodic Table, some of the products of their combination (in the form of minerals) are foreign to our Earth.

Though it was long felt that meteors must be of the same nature and composition as meteorites, it was not possible to verify the surmise by direct chemical methods, as the very appearance of meteors signifies their extinction, and nothing but their scattered ashes can be got hold of, if at all recovered.

Visual observations of spectra of meteors were made between 1864 and 1882, and these spectra were found to be either continuous or to consist of bright lines, an orange-yellow line indicating the presence of sodium and a green line identified with one of magnesium.

Accidentally some meteor spectra were photographed while arranging for photographing the spectra of stars. Eight of these photographs obtained between 1897 and 1924 were found to consist entirely of bright lines. During the last two months of 1931 an observation programme was fitted out at Harvard and resulted in the photographing of a ninth spectrum which was found to consist of some 42 bright lines (P. M. Millman, *Harvard Annals*, Vol. 82, no. 6, 1932). A systematic examination of the lines of the several spectra revealed, beyond doubt, the presence of iron, neutral and ionized calcium, magnesium and aluminium, with a possible indication of chromium and silicon.

In his second paper dealing with his work at Harvard on more recent spectra (*Harvard Annals*, *82*, 7, 1932), Millman tentatively divides them into two main types :—(1) in which the H and K lines of ionized calcium constitute the most prominent feature; and (2) in which almost all the lines are due to iron, ionized calcium being markedly absent. The difference between the two types originates probably in differences in the degree of excitation in the meteoric vapour. Meteors with spectra of the first type appear above 80 Km. height and are analogous presumably to the stony or aerolite class of meteorites. All the Leonid spectra examined belonged to this type. Meteors of the second type appear below 80 Km. height and correspond to the iron or siderite class, their greater specific gravity, perhaps, allowing them to penetrate deeper into the atmosphere.

"In all spectra the lines arising from the lowest level in the iron atom are very strong and the excitation in the iron vapour corresponds to furnace temperatures ranging from 1700° to 3300°K. The higher the degree of excitation the greater the geocentric velocity of the meteor."

No lines due to the constituents of the air have as yet been observed in meteor spectra, doubtless because the ultimate lines of the atmosphere are present far in the ultra-violet and the light of the incandescent vapour distilling off from the nucleus of meteorites is much more intense than that of the phosphorescent air.

Bursts noticed along meteoric trails present a more complex problem. Effective excitation seems to be lower at bursts than during the fainter parts of the trail, possibly due to "relatively greater predominance of temperature radiation over impact radiation at these points," the latter radiation apparently favouring the appearance of calcium.

Another perplexing but equally fascinating problem is the persistence of luminous trains, that some times continue for over an hour after the extinction of the meteor itself, and spread over several hundred cubic miles of space. Photography has been successfully employed to the study of this phenomenon, but the real clue to its secret can be obtained only through spectroscopic analysis. Their light is unfortunately very feeble and the uncertainty of their apparitions throws in an element of chance which makes systematic research exceedingly difficult.

Suitable equipment of meteoric observatories on hill stations of high altitude and clear atmosphere, with the co-operation, perhaps, of daring aerial navigators, may in due course provide reliable observational data and thus prepare the way for a correct solution of the problem. Theories are not lacking even in the present state of knowledge.

C. C. Trowbridge has tried to explain the persistent luminosity of meteor trains as arising from the after-glow of nitrogen (*Ap. J. 26*, 95, 1907 and *Proc. Nat. Acad. Sc. 10*, 24, 1924). In his earlier paper of the two above-mentioned, he says that the luminosity of meteor trains may be explained as due to phosphorescent glow caused by the gradual recovery of the atmosphere from the physical and chemical changes that may have been produced in it by the sudden motion of the meteor. The phenomenon is observed in those regions of the atmosphere that lie between 70 and 103 Km. altitudes with a mean height of about 87 Km.—that is to say, in the E region or lower layer of the ionosphere. This in itself is a strong argument in favour of Trowbridge's theory that meteor trains are due to ionization of the air.

Observation shows that a meteor train develops along the track of a meteor long after the meteor proper has moved forward a considerable distance, as if the track itself swells up, suggesting a rather leisurely expansion of hot gases in all directions from the track, their pent-up heat slowly assuming the form of energy of luminescence.

The pure spectrum of a meteor train taken independently of that of the meteor has never been photographed. When this is accomplished it will doubtless provide data that will place Trowbridge's theory on a firmer basis.

Much important work has been done of late at the Bell Telephone Laboratories to study the ionizing effects of meteors. Mr. A. M. Skellett, in *Proc. I. R. E.* for February 1935, writes a very interesting account of these effects deduced from radio data. They may be summarized as follows :—

(1) 'A rather large shower is necessary to affect appreciably the behaviour of the trans-Atlantic short-wave radio-telephone circuits of the American Telephone and Telegraph Company, since these circuits are normally under a continuous bombardment by random meteors.'

(2) Sudden increase in ionization in the E region is correlated with the visual observation of a number of bright meteors passing near the Zenith. For the brightest meteor observed from the Leonid shower of 1932, the ionization increased to a value greater than that of summer noon conditions, *i.e.*, when the Sun's ionizing effect is greatest.

A characteristic feature of some meteors is their tendency to appear in groups or showers. Meteoric showers are interesting not only from an aesthetic or spectacular point of view ; they have contributed much to our knowledge of the upper air and of diffuse matter gravitating in the voids of inter-planetary space.

By far the most important meteoric showers of all times are the Leonids. They appear to diverge from a point not far from γ Leonis. In itself, the divergence is merely an effect of perspective, as the meteors proceed towards the Earth in parallel paths. Their point of divergence is called the radiant. Leverrier, in 1863, showed that the Leonids move in the orbit of Tempel's Comet of 1866 I.

They are a comparatively recent capture. Calculation shows that in 126 A. D., they made a close approach to Uranus, whose gravitational attraction changed entirely the shape and size of their orbit and reversed even their direction of motion round the Sun ; so that they move, since that year, in an elliptic orbit with its perihelion point lying close to the Earth's orbit, its aphelion point extending only a little beyond the orbit of Uranus; and their direction of orbital motion is opposite to that of the planets.

The richest showers of this swarm of meteors during modern time occurred in 1799, 1833, and 1866, on the night of November 12-13, though they appear at a more or less maximum intensity every 33. 25 years—this being the period of their orbital motion. At their latest epoch they were expected to come out in fairly large numbers during the second week of November, from 1931 to 1934, but in spite of careful watching all over the world there has been a general disappointment on the whole. The younger generation, however, can hope to have better luck during their next return in 1966 or thereabouts.

A number of enthusiasts of meteoric astronomy have ransacked old chronicles and brought to light records of rich Leonid showers that have occurred in by-gone ages. Prominent among these are H. A. Newton of Yale, W. F. Denning of Bristol, and Hirayama of Japan. All the known showers observed in Japan, Korea and Manchuria (with some in China), between the 10th and the 17th centuries are from Hirayama's catalogue. H. A. Newton gives a list of 13 showers obtained from various sources commencing with 902 A. D. and going down to 1933. The late Dr. W. J. Fisher of Harvard has referred to their work in the October 1934 issue of the *Telescope.*

Two of the Leonid showers given by H. A. Newton (*viz.* those of October 14, A. D. 902 and 1202) seem to have been recorded primarily by Arab observers. Prof. Krenkow of Bonn sent me recently a list of meteoric showers and fire-ball apparitions described in the *Kitab al-Muntazam* of the great Arab encyclopaedist, Abdar Rahman Ibn al-Jauzi (born 1114 and died 1201 A. D.), who was a professor at the famous Nidhamiyya College of Baghdad. They were observed between 925 and 1066 A. D. One of the showers given in this list, that of 13-14 October, 935, which occurred during the Caliphate of Al-Radi Billah is undoubtedly a spectacular display of Leonids. Prof. D. S. Margolionth of Oxford tells me that Ibn al-Jauzi's account of this shower can be traced to the observing astronomer Thabit bin Sinan. Thabit's statement that the shower "was observed in Baghdad, Kufah and the adjoining regions and was unparalleled and indeed unapproached in intensity"—(Vide *Eclipse of the Abbasid Caliphate*, 4, 373), gives an idea of the richness of the shower.

H. A. Newton mentions in his list above referred to two Leonids of that particular epoch, one of October 14, 931 and the other of Oct. 14, 934. It is interesting to know that Thabit's shower of the same epoch was on an exceptionally grand scale.

The successive occurrence of Leonid showers for 3 or 4 years at each epoch shows that these meteors are spread over a fair distance of their orbit. But they form rather a *narrow* swarm inasmuch as the Earth passes obliquely through them in only six hours.

It may be mentioned here that Fisher, who got together much useful literature concerning past Leonids, indicates in his paper above referred to that in the period extending from 902 A. D. to present times, no records have been traced of showers belonging to some 12 epochs. Further search may fill these gaps. Oriental historians in the past have evinced a great partiality for introducing accounts of contemporary cosmic events in their description of mundane matters. Workers in this field may come across references to some of these missing showers. But it must also be borne in mind that our recent experience with Leonids shows that every epoch need not necessarily bring in a spectacular display.

Next in importance are the Perseid showers of August 12, following in the track of Tuttle's Comet 1862 III. A good feature of this swarm is its somewhat uniform distribution over its entire orbit, so that they—the Perseid meteors—rarely fail to delight the night-watchers at the expected time every year, though always falling short of the grand spectacular displays offered fitfully by their capricious compeers, the Leonids. Some of the oldest showers mentioned in the annals of old China are Perseids.

Among the more or less regular showers of modern times may be mentioned the Geminids of December 13, and the Orionids of October 19, other important showers are the Lyrids of April 21, connected with Thatcher's Comet of 1861, the Andromedes of late November associated with Biela's Comet which broke up in 1846 and disappeared in 1852 and the η Aquarids of early May connected with Halley's Comet.

Of late years Giacobini's Comet (period about $6\frac{3}{4}$ years) has been presenting the Earth with fine meteoric displays on October 9. But we, in India, are not favourably situated to watch them at night. Pons-Winnecke's Comet of 1921, Lexell's of 1770, Denning's of 1881, Daniel's of 1907 and Zanoth's of 1739 have also contributed to more or less striking meteoric showers.

The relationship between comets and meteors consists in the similarity between the orbits of the several periodic comets and those of the corresponding meteoric swarms. This was verified in 1872 when a magnificent shower was observed as the Earth passed through the old track of Biela's Comet which had disappeared in 1852. It does not follow, however, that every meteoric swarm (manifested by a shower) results from the break-up of a comet. Prolonged observations of Leonid showers suggest that these meteors and their co-orbital comet may have been derived from an identical cosmic cloud.

Systematic observations in Europe, America, and the British colonies have led to the identification of over 500 radiants associated with more or less small scale showers. An index to some 320 radiants of southern meteoric showers by R. A. McIntosh of Auckland, New Zealand, is published in the *Monthly Notices* of the Royal Astronomical Society, *95*, 8, 1935.

In addition to the usual type of showers that extend generally for a number of days during particular epochs, fine showers are seen occasionally that last only for a few minutes or so, coming off all of a sudden and stopping more or less equally suddenly —thus indicating a swarm moving in an orbit of exceedingly narrow width. The present writer had the good fortune to observe a remarkably rich shower on November 21, 1935 between 18 h. 50 m. and 19 h. 10 m. Universal Time, from a radiant in the constellation of Monoceros—(Vide *Nature* for Nov. 30, 1935; *the Observatory* for January 1936, and *Popular Astronomy* for February 1936).

When a meteor survives its passage through the air and falls as a meteorite, it often gives rise to characteristic phenomena. Meteorites have been seen to break off from fire-balls or bolides when the impact of the air against the front surface of the meteor proves too much for its particles to hold together. This breaking-up of the meteor gives rise to terrific explosion like the firing of artillery or a clap of thunder, followed often by a low rumbling noise and sometimes by a sound not unlike that of tearing calico—caused no doubt by the sudden expansion of heated air and its subsequent return to normal position.

Very often meteorites do not penetrate deep into the soil—the depth depending naturally on the nature of the soil and the final velocity of the falling body. Occasionally, large meteorites have been found to make crater-like depressions round the spot where they have fallen, as in the case of the Henbury craters in Central Australia.

The huge crater near Cañon Diablo in Arizona and some smaller ones discovered recently in Wabar, Southern Arabia, have been examined carefully and the prevailing opinion is that they have been formed by the impact of gigantic meteorites, several thousands of tons in mass, with the Earth's surface. The planetary velocity of such large masses is not appreciably reduced by the friction of the air (owing to the small ratio of their surface to mass); and when they strike the Earth the whole of their energy is converted into heat which volatilizes both the meteorite and the material of the Earth's surface that comes into contact with it. The moisture in the rocks suddenly passes off as steam and scatters, round the rim of the crater thus formed and outside it, the debris derived from the meteor.

The meteor crater of Arizona is a circular depression 4,000 feet in diameter, its walls sloping upwards from the centre and rising to a height of 130 to 140 feet above the surrounding country. Its depth is about 570 feet. Thousands of pieces of meteoric iron (iron alloyed with about 7 p. c. nickel and a little cobalt) have been found *outside* the rim of the crater. Some platinum and iridium and small pieces of white and black diamond have also been obtained around it—the diamond having been formed by the crystallization of organic carbon dissolved in the iron fused by the heat of the impact and subjected to tremendous pressures. It was doubtless due to a careful study of these 'meteoric finds' at Cañon Diablo that Moisson succeeded in his manufacture of artificial diamond or "moissonite."

There is every reason to believe that the first metallic iron that man ever handled was of meteoritic origin. Though the number of iron meteorites (siderites) that have actually been *seen* to fall is only 23 or 24, the total amount of meteoritic iron *discovered* on the surface of the earth is very large. The largest known irons are the 60 ton Hoba meteorite, discovered in S. W. Africa in 1920, the 36½ ton meteorite known as Ahnighito or "The Tent" brought by Captain R. E. Peary from Greenland to New York, and the 27 tons iron on the farm of El Ranchito, near Bachubirito, in Mexico. Even in modern times man has utilized meteoritic iron to make his favourite weapons, crediting them with abnormal properties owing to their extra-terrestrial origin. As for example, Emperor Jehangir had two swords made out of the meteorite that fell at Jalandhar in June 1621. James Sowerby made a sword for Czar Alexander of Russia in 1814, out of the Cape of Good Hope iron meteorite, which he described in an issue of the *Phil. Mag.* in 1820.

Very likely many implements of peaceful enterprise also have been made out of such irons in Ancient India. That is why there is so little meteoritic iron "found" in our country. All that was available at the surface must have been used up long ago.

It may be interesting to note that an iron meteorite weighing 16 Kilograms was found at Kodai Kanal in 1898. According to Phipson, the first iron *seen to fall* was the one that fell in the province of Djorjan in or about 1009 (on the authority of Avicennes).

By far the greatest number of meteorites that have been seen to fall are stony and are technically known as aerolites. The largest aerolite, however, is much smaller than the siderites above referred to. Aerolites weather more quickly and this is one of the reasons why so few large-sized stone meteorites of pre-historic falls have been 'discovered."

The subject of meteorites is much too vast to be dealt with in this paper on meteors. Even a brief notice of it would require a separate treatment.

Synthetic Plastics

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THE appointment of Prof. Dr. H. K. Sen as the Director of the Lac Research Institute, Nankum, Ranchi, has drawn the attention of the public to the position of shellac as a plastic material and to the heavy inroads made by synthetic materials in this field. This competition of synthetic materials is of great importance to India which holds a practical monopoly for shellac. India's export of this article fell to less than 300, 000 cwt. in 1932, but it is gratifying to learn that in recent years the trade has resumed its normal figure of about 5, 50,000 cwt. In the year 1914, the price of shellac in England was only about 60 shillings per cwt., but during the Great War, the price rose by leaps and bounds and for a time in 1920, it reached the amazing figure of 1,000 shillings per cwt. This unprecedented rise in price stimulated research in western countries for suitable substitutes with the advent of which the price of shellac began to fall and reached the pre-War figure of 60 shillings per cwt. in 1932, though it has risen again in recent years to about 100 shillings per cwt. on account of increased demand created by new uses found for it.

With the fate of indigo, alizerin, camphor, and other natural products to serve as an object lesson, the Government of India appointed Messrs. Lindsay and Harlow to make an enquiry into the position of the lac industry; they acted on their recommendation with laudable promptitude, and established and financed the Lac Research Institute at Ranchi. The justification for this advanced policy of the India Government will be found in the figures quoted above which show that things are brightening up again since the year 1932, due mostly to new uses found for shellac both here and abroad. The formulation of a bold scheme of research, both pure and applied, and its efficient carrying out under the able guidance of Prof. Sen will, it is hoped, further improve the situation and bring the much-needed economic relief to the extremely poor peasants of the lac-growing districts.

If shellac is still holding its own in the face of serious competition from synthetic rivals, it is more due to its cheapness than to any inherent superiority in its properties, and the moment its price is raised again, synthetic products will rapidly take its place. Synthetic resins have largely replaced shellac in paint, varnish, and electrical industries, but have not been able to shake its position in the gramophone record industry which consumes about 40% of the total shellac produced. The resiliency exhibited by shellac makes the records comparatively immune from the wear and tear of a needle. But there is no reason for complacency; extensive investigations are being made to-day on the suitability of other materials for record manufacture, and flexible, non-brittle records with excellent sound reproducing capacity have been made from cellulose acetate and other plastics, and if their price can be sufficiently lowered, they will offer serious competition to shellac even in this field.

These so-called "synthetic resins" have no relationship with natural resins in chemical composition and their properties are by no means confined to those of the natural product. According to the raw materials used and the methods of manufacture followed, their physical and chemical properties can be varied over a wide range at will and this fact alone gives the synthetic product an advantage over the natural. Some of these products (*e. g.* Novolac) are liquid, some are easily fusible solids which revert to the solid state when cooled (reversible thermoplastic), while others become plastic when heated and then become permanently hard (irreversible thermoplastic). As they become plastic at a high temperature, they can be shaped, moulded, or cast into different forms and shapes.

The synthetic resin industry has grown to an enormous extent during the last 10 years and is still rapidly growing. The *British Plastic Year Book* (1933) mentions the names of not less than 900 firms engaged in this trade. The total world production has been roughly estimated at 30,000 tons and their value at about £ 20, 000, 000. It is interesting to note the rapid growth of the industry in Soviet Russia on the one hand and in the United States of America on the other. Before 1928, synthetic plastics were unknown in Russia. Factories were however established during the first five year plan and the production which amounted to 83. 4 mill Rbl. in 1933 quickly rose to 115 mill Rbl. in 1934 and in 1935 the actual production has been estimated at 176 mill Rbl. This figure however amounts to only 15% of Russia's internal needs and it has therefore been planned that the production will be raised to 250 mill Rbl. in 1936, 460 mill in 1937, and 675 mill in 1938. Extensions in different factories have already been taken in hand according to this plan and the different plants are being worked at their full capacity.

The United States of America, the home of Bakeland of Bakelite fame, produced about 45 mill lbs phenol plastics of all types in 1934 but in 1935 this figure rose to about 64 mill lbs and the average selling price was reduced from 15 cents to 14 cents per lb. Besides, America produces large quantities of other types of synthetic resins as well.

The reason for this phenomenal growth may be found not only in the discovery of a large variety of synthetic resins with suitable properties and a wide range of application but also in the improved technique of manufacture. The suitability of this material for different purposes may be gauged from the fact that to-day there is hardly an industry which does not use these products in one form or another. The moulding operation now takes less than a minute whereas formerly it required more than 30 minutes. In the case of thermo-setting resins, the time of hardening has been reduced from about an hour to less than 3 minutes. The articles can be obtained from moulds with sufficient glaze, making subsequent polishing unnecessary. In the case of reversible thermoplastics, complicated forms can be made by welding together different parts, and shavings and other wastes can be re-used just like the original material while the irreversible thermoplastics can be used at a high temperature without the danger of softening. These plastics can be incorporated with cotton, woodmeal, soot, clay, pigments, etc. with the object of improving their properties and appearance. The hardened mass can be cut, drilled, and otherwise operated at will, or can be cast into different shapes. These properties have added to their usefulness in industries.

Of the different synthetic resins, Bakelite is most widely known. In the year 1908, Dr. Bakeland first produced this article as a commercial commodity in U. S. A. and to-day the world production of this article may be estimated at over 175 mill lbs. per annum. The production of raw materials, phenols and formaldehyde, has correspondingly increased. Thus in 1923, only 3¼ mill lbs. of phenol and 24 mill lbs. of formaldehyde were produced in U. S. A., the figures for 1929 were 24 mill and 52 mill respectively and these figures must have been further increased by this time. The present-day limitation of the production of phenol in sufficiently large quantities is however acting as a handicap to further development of this class of resins.

The nature of the catalyst is an important factor in deciding the character of the product to be obtained. If an acid catalyst is used, a permanently fusible resin, "Novolac", is obtained, which can be converted into solid form by treating it again with formaldehyde and ammonia or with hexamethylene tetramine. If a strong basic catalyst like ammonia be used from the very beginning, an easily fusible solid resin can be obtained, whose properties are in many respects similar to shellac. When it is heated in the mould, it becomes permanently hard ; the time of hardening can be regulated by controlling the temperature and the amounts of formaldehyde and ammonia. This property has opened up a wide field for its application.

In itself, Bakelite is rather brittle but when incorporated with fibrous materials like cotton, its tensile strength can be increased to about 14,000 lbs. per sq. inch. Hence, shock resistant materials like golf sticks, fishing reels, motor-car parts, silent waterproof gears, etc. are made from it. Its highly insulating character and the resistance of its properties to changes of temperature and humidity have made it particularly suitable for electrical goods, such as plugs, sockets, switch boards, armature fittings, radio condensers, and housings, etc. It can be heated to a high temperature without catching fire. Heat resisting materials such as heater plugs, cooking utensil handles, ash trays, smoker's pipes, etc. are therefore made from it. In the metal industry, grinding wheels are made of abrasives bonded with phenol resins in place of shellac. It has been reported that one such industry in U. S. A. saved 30,000 dollars a year by the use of these improved grinding wheels. Similarly, their use in the manufacture of break-linings and clutch facings in motor cars has led to greater efficiency and lower cost. In brushes, bristles are fixed with this Bakelite cement which is also used for sealing electric lamps into its metal and for other purposes as a high vacuum cement. As it can be cast into different forms and can be incorporated with colouring matters, decorative articles with beautiful pictures and designs on the surface can be made. Dental plates made from it can be dyed to the colour of the gum; they possess strength and lightness, and are odourless and non-absorbent and are therefore quite safe for use. Beautiful jewellery and other novelties, such as clock cases, motor car parts, etc., are also made by casting.

By impregnating paper with these resins thick sheets and boards with glassy surface are obtained and are used for table tops, spools and bobbins, window sills, etc. If properly coloured, it can be made to look like marble and in this form it is largely used as a flooring material. Tables, chairs, cups, saucers, etc., both for indoor and outdoor use, are largely made from it. The possibility of further expansion for its use was indicated in an exhibition at South Kensington where a beautiful "all-plastic" room was exhibited. These synthetic materials are made cheaper by impregnation with woodmeal and owing to their resistance to bacteria and moisture, they are steadily replacing wood and metal for a variety of purposes.

In oil-soluble form, they are largely used in the varnish industry, either alone or in conjunction with natural resins. They protect surfaces better, as they are more resistant to water, to dilute acids and alkalies and to the action of solvents like alcohol, benzene, etc. It has been reported that actual tests carried out under tropical conditions have proved a very high protective value of such coatings. Soft and flexible water-proofs are now made by treating fabrics with these phenol resins. These rain-coats stand aging and climate better and can be ironed.

Other Synthetic Resins

Another class of synthetic resins known as amino-plastics are made from urea or thiourea and formaldehyde. The manufacturing process is similar to the phenol resins. Non-fragile, fire-resisting articles with a wide choice of colour and glaze are made on the same lines as Bakelite. While phenol plastics are susceptible to the action of strong alkali, the urea plastics are more resistant to their action, and owing to their non-fragile and transparent nature, they have a bright prospect for the future. In the last few years, they have gained great popularity and the supply of raw materials which can be obtained in large amounts places no limitation on their production.

In Germany a special class of plastics are being made by the condensation and polymerization of triethylamine derivatives with long chain unsaturated acids, such as those present in linseed oil or in colophonium. These products are not acted upon by dilute acids, alkalies, or alcohol. They are soluble in drying oils and in many volatile organic solvents and are therefore much valued in the varnish industry.

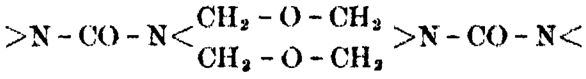
Glyptal resins are made by the condensation of glycerol and polycarboxylic acids, such as pthalic acid. It is obtained as a waterwhite syrup or easily fusible resin suitable for the varnish industry. For thermo-setting articles, it is usually cast in different forms and hardened. Owing to its transparency, it is much valued for pencils, pens, and other fancy goods. The process of final hardening is however a matter of several hours. It is largely used for micanite sheets and for insulation, as it exhibits the property of sticking to mica like shellac—a property not shown by other synthetic resins.

Venylite resins form another important group and are made by the polymerization of aliphatic and aromatic venyl compounds, and are often coupled with unsaturated fatty acids.

Coumarone resins which have a very large output are formed by the polymerization of indene, styrene, coumarone, etc., present in solvent naphtha by means of sulphuric acid. It is thus obtained as a by-product in petroleum and coal-tar oil refining and are largely used for spirit and oil varnishes and for printing inks.

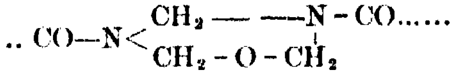
Casein plastics are made from this milk product and formaldehyde. Since the advent of the synthetic plastics, their commercial importance has to some extent suffered. But in India where the agriculturists find it difficult to dispose of their milk at a remunerative price, this new use for casein would have a special value of its own.

Though great strides have been made in the manufacturing technique, the chemistry of these substances is little understood. Vigorous investigations are being made to lift the veil of darkness that shrouds the chemical compositions of these substances but with little success. It may on the whole be said that these substances are mixtures of long chain molecules of different sizes formed by polymerization and condensation processes. It has been suggested that liquid phenol-formaldehyde resins mostly contain alcohols of the dihydroxy-diaryl-methane series, $OH\ R'\ CH_2\ (R''OH\ CH_2)_{n-2}\ R'OH$ (where Rs'tands for C_6H_5 and R″ for C_6H_4), but there are innumerable possibilities of isomerism (ortho, meta and para) and the relative position of OH and CH_2 groups in the molecule is uncertain. In urea resins, it is still an open question whether it is constituted of a mixture of chain molecules of the type $OH.\ CH_2.\ NH.\ CO.\ NH.\ CH_2.\ NH.\ CH_2.\ NH.\ CO.\ NH.\ CH_2.\ NH\ldots\ldots$ or of closed ring compounds having the following structure:



$$>N-CO-N<\begin{matrix}CH_2-O-CH_2\\CH_2-O-CH_2\end{matrix}>N-CO-N<$$

or



$$..\ CO-N<\begin{matrix}CH_2 ——— —N-CO\ldots\ldots\\CH_2-O-CH_2\end{matrix}$$

Apart from these purely scientific investigations or attempts to find new plastics, modern researches are proceeding mainly in two directions, *i. e.,* (1) evolution of mixed plastics having special properties by the use of different types of raw materials during polymerization and condensation, and (2) modification of the properties of each class by the introduction of cross linkings with a view to form three dimensional molecules.

(To be continued).

Conference on Nuclear Physics

M. N. Saha, Pannalal Kapur

[Attempt has been made to give a clear and connected account of all matters of importance discussed on this occasion. This has necessitated the inclusion of the historically or otherwise relevant matter, which was pre-supposed on the part of those who attended the conference, and without which the account here would have been quite unintelligible. Mathematics has been altogether avoided, and only the general line of thought is stressed]

For some years past, Professor Niels Bohr has been in the habit of calling a private conference of physicists at Copenhagen during summer. The last was held in 1934. This year's conference was held in the Institute for Theoretical Physics at Blegdamsvej 15, Copenhagen, from June 17 to June 20, and was attended by about one hundred physicists (most of them original workers in nuclear physics) from different parts of Europe and America. For four days the Institute was the scene of very lively and instructive discussions on the latest branch of physics. Among those who attended the following may be mentioned:

Profs. M. Born ; Franck ; von Heuesy ; Stern ; Pauli ; Heisenberg ; Meitner ; Oliphant ; Thomas ; Jordan ; Kramers ; Weisskopf ; Delbrück ; Heitler; London ; Placzek ; Teller ; Frisch ; Müller; Kalckar ; Caisimir ; Peierls ; Weizsäcker; Amaldi; Wick; Koch; Holtsmark ; Trumpy ; Bhaba ; Jakobsen ; Saha ; Richardson Jr. ; Reiche ; Uhlenbeck ; Dunning ; Hund ; Rosenfeld ; Euler ; Ehrenfest Jr. ; Hulme ; Jehle ; Rasmussen ; Mrozowsky ; Waller ; etc.

Professor Bohr welcoming the guests said in an introductory speech that he was glad that so many eminent physicists working in different parts of the world and on different branches of nuclear physics had responded to his invitation and assembled at Copenhagen to discuss their work and exchange their ideas. Knowledge in this direction is progressing so rapidly that one does not often believe what he did two years ago. Within the last few years two new 'elementary' particles, neutron and positron, have been discovered, and the existence of two, neutrino and negative proton, has been postulated though not yet experimentally proved. He concluded by remarking that the conference had representatives from almost every school of workers—Cambridge, Rome, Paris, Berlin, and other places.

Dr. Jakobsen was the first to speak. He gave an account of the work which he had carried out at the Institute of Copenhagen on the scattering of γ-rays from Th C″. It is well known from the theory of Compton effect that encounters between electrons and photons (light quanta) can be treated mathematically according to the laws of conservation of momenta and energy. Such a treatment leads to a correspondence between the direction of the scattered quanta *and the direction of the recoil electrons.* Some years ago Bothe and Geiger established the correctness of Compton's theory by an experiment in which the coincidence between the scattered quanta and the recoil electron was established. This classical experiment has generally been taken to form the most rigorous experimental proof of the law of conservation of momenta and energy when applied to processes in which individual elementary particles are involved. The experiments had hitherto been done only with X-rays, and it was not quite sure whether similar results could be extrapolated for the γ-ray region.

Some months ago Shankland performed an experiment, which was reported in the *Physical Review*, with γ-rays from Ra C, and obtained rather startling results—results which could not be reconciled to the Compton theory. He found that there was no correspondence between the direction of scattered quanta and *the recoil electrons* and that the same number of coincidences were obtained in directions not predicted by the theory as well as in directions predicted by the theory. Thus the validity of the conservation laws was questioned. Dirac, in a short article in *Nature*, expressed the view that Shankland's experiment definitely proved the non-validity of the conservation laws when applied to individual encounters between particles and photons, and in the death of the basic principle saw the possibility of setting up a new system of quantum electrodynamics which would have better success in dealing with nuclear phenomena than the older quantum electrodynamics.

In view of the revolutionary nature of Shankland's experimental results and the support given to them by one of the most distinguished theoretical physicists, it was thought necessary to carry on further experiments with γ-rays. Many physicists in Europe and America have applied themselves to this task, and the results of Bothe in Heidelberg, Dee in Cambridge, and Jakobsen in Copenhagen are now known. All of them contradict Shankland's experimental findings. It was pointed out that the main defect in Shankland's experiment was that he used a beam of γ-rays that was not homogeneous and consequently obtained coincidences even in directions not predicted by the theory. Also the geometry of his experimental arrangement was insufficient. The new experiments favour the view that the Compton scattering holds for high-energy photons as well.

Prof. L. Meitner gave a detailed account of the work which she had carried out at Berlin on the transmutation of uranium by neutrons and the consequent formation of elements of atomic numbers greater than 92. The work was first carried out by Fermi, who claimed the formation of elements 93 and 94. This was contradicted by Gross, and a later work again confirmed Fermi's view. It was held that a new rarer group begins to be formed after the atomic number 92, and therefore it was not chemically possible to separate the various elements formed and investigate their properties separately. Prof. Meitner showed that according to her experiments the new elements formed correspond to a *new transitional group*. She was almost definite of the production of Eka Re (93) and possibly also of the elements Eka Os (94), Eka Ir (95), and Eka Pt (96) as a result of the β-ray disintegration of the uranium nucleus when bombarded by neutrons.

Next Amaldi and Wick gave an account of the work carried out at Fermi's Institute in Rome on the increased efficiency of the production of artificial radioactivity by slow neutrons. It is well known that neutrons on account of being chargeless particles are able to penetrate much further into the nucleus than protons or α-particles, which on account of their positive charge suffer a repulsion from the nucleus. This fact was first made use of by Fermi in producing artificial radioactivity in ordinarily stable nuclei. By using a strong source of neutrons, *viz.*, a mixture of beryllium and 800 m gms of radium, Fermi and his collaborators could obtain induced radioactivity in almost all the elements up to uranium. Fermi, however, discovered that the efficiency of the neutrons to produce artificial radioactivity was greatly increased if they were made to pass through blocks of paraffin. The neutrons by their encounters with hydrogen-nuclei in their passage through paraffin get very much slowed down, as the masses of the colliding particles are almost equal and it is these slow neutrons that are responsible for the increased efficiency. For such slow neutrons the encounter cross-section is enormously increased—so much so that in the case of gadolium it is as high as 30,000 times the nuclear cross-section. With such slow neutrons a 'resonance' effect is also obtained, that is to say, within certain velocity limits about hundred times more neutrons are absorbed than on either side of the range.

According to a view expressed by Prof. Bohr, a full account of which appeared in *Nature*, this resonance phenomenon of neutron capture is of great importance in the investigation of the constitution of nuclei, and Bohr in collaboration with Kalckar has obtained an expression for the capture cross-section which looks very much like the formula for *anomalous dispersion* in light. Or alternatively, this phenomenon of neutron resonance capture may be said to correspond to Auger process in X-rays.

Next Heitler gave an account of his work on the production of 'Bremstrahlung' by high-energy electrons moving in the coulomb field of nuclei. He said that the work was undertaken in order to find out how much of the energy loss of cosmic-ray particles was due to this mechanism, *viz.*, radiative collisions. His theory predicts the energy loss to be proportional to the energy content of the original beam and also to the square of the nuclear charge. Former experiments did not conform to the theory, but the new experiments of Anderson agree very well, and now one can safely say that the theory stands the test of experiments with particles of energies up to 10^9 or a thousand million electron volts.

Dr. Oliphant from Cambridge gave an account of the work done at the Cavendish Laboratory. He said that the work done at the Cavendish Laboratory and other places showed that atoms with all mass numbers from 1 to 212 have been found to exist, the only exception being mass number 5, which has not been so far definitely proved to exist, though its occurrence as ^5_3Li has been reported from America. At the Cavendish Laboratory they searched for it as ^5_2He from the bombardment of ^7_3Li by deutrons according to the reaction equation

$$^7_3Li + ^2_1D = ^5_2He + ^4_2He$$

but were unsuccessful.

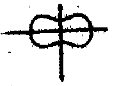
In the Cavendish Laboratory homogeneous neutrons are obtained from the bombardment of deutrons (heavy hydrogen ^2_1D) by deutrons. The primary beam of ^2_1D, accelerated through any voltage, is made to impinge on sheets of $Al_2(DO)_3$.* It is estimated that about 10^6 bombarding particles produce one neutron; the production of neutrons also depends upon the voltage according to the law $N = N_0\, e^{aV}$, up to an upper limit of 1×10^6 volts. By this method a source of neutrons which corresponds to 4.0 gms beryllium-radium source is obtained. The reaction equation for neutron production may be written as

$$^2_1D + ^2_1D \longrightarrow ^3_2He + ^1_0n.$$

But this not the only reaction possible; we have protons according to

$$^2_1D + ^2_1D \longrightarrow ^3_1H + ^1_1H.$$

The most interesting thing about the deutron-deutron reaction is that the angular distribution of both the neutrons and the protons is exactly identical. Further, this angular distribution is not isotropic and may be represented roughly as shown on the left. Such a distribution indicates certain restrictions on the spin and angular moments in the reactions given above, but their exact nature is not yet fully known.



One of the most important problems in nuclear physics is the nature (not yet known) of the forces between the elementary particles. A number of workers spoke upon this subject. Some years ago Heisenberg showed that we could assume the nucleus to be made up of neutrons and protons. Ordinarily the protons repel each other, but within the nucleus repulsion changes into attraction, or, put more precisely, a stronger nuclear attractive force overcomes the ordinary coulombian repulsive force. According to present views, three kinds of forces are involved in the building up of a nucleus, (pp) force between two protons, (nn) force between two neutrons, and (pn) force between a proton and a neutron. It has been shown that these forces are very large within nuclear dimensions but fall off very rapidly with increasing distance. On account of the convenience in mathematical calculations these forces are supposed to vary as e^{-ar^2} with the distance r. The (pn) interaction force is believed to be much larger than the (pp) or (nn) interactions, which in turn are believed to be almost equal. Attempts are being made to find out the magnitude and law of these forces by determining the scattering of one swarm of particles by another. Teller reported experiments on scattering of protons by protons within the range 600—900 K. V. The results of the experiments certainly show deviations from what would be expected from purely coulombian repulsive force, and can most probably be explained by assuming an attractive force expressed as a potential hole of 2.8×10^{-13} cms radius and 10 Mv depth. Goldhaber reported experiments on (1) scattering of neutrons by protons, (2) capture of neutrons by protons leading to the formation of the deutron, and (3) decomposition fo deutrons by quanta. None of these experiments at the present stage appear to be decisive; Goldhaber's experiment on the scattering of slow and fast neutrons by protons gave cross-sections, the variations of which could not be understood on the assumption that the forces between the particles were of the nature of short range forces, on which assumption it would be necessary to postulate that the deutron may have excited nuclear states.

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* $Al_2(DO)_3$ is the heavy hydrogen compound corresponding to the ordinary hydrogen compound $Al_2(HO)_3$.

Max Born gave an account of his new work on the modification of Maxwell's equations. These works have been published in several numbers of the *Proceedings* of the Indian Academy of Sciences of Bangalore and of the Royal Society. He remarked that it was generally agreed that Maxwell's equations in their present form could not explain atomic phenomena, the most glaring case being that of the mass of the electron which becomes infinite if the electron is considered a point-charge. In his new electrodynamics this difficulty does not arise. His equations are also in qualitative agreement with the changed form of Maxwell's equations deduced by Heisenberg, Euler, and Kockel in their work on the scattering of photons by photons.

The same problem of electrodynamics has been approached by Weisskopf from a different standpoint. The vacuum, according to Dirac's theory of negative energy states, is no longer a void, but contains electrons filling all the negative energy states; it ought to have a polarizability, which will be affected by an electromagnetic field. Weisskopf calculates the polarizability of the vacuum in the presence of an electromagnetic field by making use of the 'relativistically invariance' property of the Lagrangian function of the system. Proceeding on these lines, he obtains an expression for the scattering of light by light which is exactly similar to that obtained by Heisenberg and Euler who had to make very lengthy and tedious calculations and made use of not very convincing assumptions to get rid of the infinities that of necessity enter into the calculations.

The greatest amount of interest was excited by Heisenberg's description of his new theory of 'shower' production, and the way he has tried to connect this mysterious phenomenon with the Fermi theory of β-ray disintegration. It was in 1932 that Prof. Bohr in a lecture to the Faraday Society pointed out for the first time that the phenomenon of β-ray disintegration formed a challenge to all existing systems of dynamics, for the simple reason that the β-rays emitted by the nucleus do not possess definite energies like α-rays, but form a continuous energy spectrum with a sharp upper energy limit, the end products being always the same and the life period of the disintegrating atoms quite definite. This phenomenon, as already pointed out, stands in sharp contrast to that of α-rays, where the life of the disintegrating atom depends upon the energy of the emitted α-particle in a way which is described by the Geiger-Nuttal relationship. The mechanical problem of the β-ray disintegration is therefore quite different, and any theory must explain the behaviour of β-particles within the nuclei and the continuous energy spectrum of Beta-rays.

Now an electron (Beta-particle) in the free state has a spin equal 1/2 and a magnetic moment equal to that of a Bohr magneton, but the magnetic moment of the nucleus is found to be a thousand times smaller than that of a Bohr magneton, thus we see that we cannot assume that a β-particle as such exists in the nucleus. Further, if we assume the presence of a β-particle as such in the nucleus, then its kinetic energy comes out to be much larger than the binding energy of the nucleus so that it could not remain inside a nucleus. Besides these, considerations of spin of the various nuclei and the statistics (Fermi-Dirac or Bose-Einstein) obeyed by them leads to the same conclusion that we cannot postulate the existence of electrons within the nucleus.

The situation became somewhat clear with the discovery of 'neutron' by Chadwick in 1932, for now the neutron and the proton could be taken as the building stones of the nuclei. Heisenberg later on showed that we could suppose a nucleus to consist of Z protons and (A-Z) neutrons. β-ray emission could now be explained by postulating that a neutron within the nucleus gets converted into a proton by giving out a β-particle, this process being analogous to the emission of light quanta by an excited H-atom. But if the process was to be mechanically definite, the electrons must have a definite energy, which, as remarked above, is not found to be the case. So here then the physicists were faced with a dilemma; they had to make a choice between the law of conservation of energy on the one hand and the definite quantum states of the nucleus on the other; it was a choice which would have, either way, meant the undoing of all that had been achieved so far. Here Pauli came to the rescue by postulating that along with the electron another chargeless particle, which was baptised 'neutrino,' is also emitted. This particle has a very small mass and shares with the β-particle the energy difference between the disintegrating atom A and the final atom B. The 'neutrino' hypothesis enables us to get over the spin difficulty if we ascribe to it the spin equal to 1/2. The neutron, proton, and the electron have been shown to possess a spin equal to 1/2 each. Now when a *neutron* changes into a proton with the emission of β-particle, we have to explain the conservation of spin. With the postulate of the neutruo β-disintegration process may be described as follows:

$${}^{1}_{0}n = {}^{1}_{1}p + {}^{0}_{-1}e + \nu$$

$$\text{spin} \quad 1/2 = 1/2 + 1/2 + 1/2$$

$$\text{charge} \quad 0 = 1 + (-1) + 0 \quad , \nu = \text{neutrino}$$

It may be mentioned here that no experimental trace of this 'neutrino' has yet been found. Neither is there any likelihood of its being experimentally detected, because the *neutrino* has no charge and practically no *mass*. In spite of this fact, there appeared to be a general agreement among the physicists assembled at Copenhagen that the neutrino hypothesis of β-decay describes the phenomenon correctly.

This hypothesis was given a mathematical precision by Fermi, who postulated that the *interaction energy* involved during the conversion of a neutron into proton with the emission of a β-particle and a neutrino may be put equal to a new universal constant g multiplied by a function of the Ψ-functions of the particles taking part in the reaction. In quite a phenomenological way analogous to Dirac's radiation theory of the interaction of atoms and the radiation field, he was able to give a general explanation of the β-decay, but quite recently important modifications in the theory have been introduced by Uhlenbeck and Konopuiski.

A further tinge of reality to the neutrino has been given by Jordan, who gave an account of the theory in which a photon is considered as consisting of a pair of a 'neutrino' and an "anti-neutrino." (The terms 'neutrino' and 'anti-neutrino' correspond to Dirac's electrons and holes or positrons). Jordan showed that one can give a consistent theory where all the reactions of light with atoms can be formally deduced by a pure theory of "neutrino-pairs."

These works, therefore, amounts to an acceptance of the situation and simply postulates the mechanical act of production of an electron by the nucleus. In the case of 'shower' production, it is found that a cosmic-ray particle which may be an electron or a positron on meeting a nucleus, suddenly gives rise to a large number of pairs of positrons and electrons ($\beta^+ \beta^-$) whose total energy may sometimes be as large as 10^{12} or million million electron-volts. As this energy is much larger than the mass of the heaviest nucleus known, it becomes evident that the energy of the shower must have come from the original particle. The point is, therefore, how the energy of the original particle is converted by the action of the nucleus into pairs forming the showers?

Dirac's theory of the electron gives a possibility of pair-production, *i.e.*, the conversion of energy quanta into β^- and β^+ in the presence of a nuclear field, but according to this theory the probability for the n^{th} order process, *i.e.*, the production of n pairs involves the factor $\left(\frac{2\pi e^2}{ch}\right)^n$ which evidently goes on decreasing with increasing n. Note that $\frac{2\pi e^2}{ch}$ is the Sommerfeld *fine*-structure constant, in other words, it means that the probability of occurrence of higher order processes is extremely small; so that this theory completely fails to give an account of the phenomenon of production of big showers, involving billions of electron-volts.

But on the other hand, if we write the energy function, making use of Fermi interaction field, then the expression involves a factor f which is equal to g/hc. If now a usual perturbation theory be applied, *i. e.*, the expression be developed in ascending powers of the interaction term, powers of the factor f will be involved. This factor is of dimension cm^2 and so must be divided by l^2. So that now in the expression for energy various higher order terms which give the probability for the corresponding order processes involve powers of factor (f/λ^2). Now as we go to high-energy particles, λ decreases till we come to a value when f/λ^2 is of the order unity. When this is the case, the probability for the higher order processes is just the same as for loworder processes, *viz.*, unity, and hence the phenomenon of showers becomes possible.

The phenomenon of the production of electrons and positrons on this theory may be pictured as follows:

Cross-section for each process

proton ---> neutron (n) + positron (β^+) + neutrino (ν) $\qquad \left(\frac{Ze^2}{hc}\right)^2 f^2/\lambda^2$

———> proton $+\beta^- + \beta^+ + 2\nu$ $\qquad \left(\frac{Ze^2}{hc}\right)^2 f^4/\lambda^6$

———> proton $+ n\beta^- n\beta^+ + 2n\nu$ $\qquad \left(\frac{Ze^2}{hc}\right)^2 \frac{f^{4n}}{\lambda^{8n-2}}$

In the case when (f/λ^2) is of the order unity, we see that the cross section for all the processes is the same, and hence we can get the 'showers'.

The academic discussions of the conference came to an end with the discourse of Prof. Bohr on 'the theory of measurements of the field strengths and charge density.' Now, according to quantum electrodynamics as put forward by Pauli and Heisenberg, the electric and the magnetic fields form two conjugate variables which means that we cannot measure simultaneously both the electric and magnetic fields exactly in the same way, as we cannot measure both the position and momenta coordinates of a particle. Pauli and Heisenberg quantum electrodynamics requires certain exactness with respect to time in the measurements of fields and charge. In a previous paper Bohr with the collaboration of Rosenfeld had shown that such an exactness as demanded by the theory was quite consistent with experimental measurements only if we took test bodies large enough and considered a continuous distribution of charge. But then Landau and Peierls tried to show that on relativistic grounds such measurements could not be possible. Bohr and Rosenfeld showed that we could measure either the electric or the magnetic field strength quite definitely according to the requirements of the Pauli-Heisenberg theory. It was further shown that the argument in favour of the possibility of measurements of the fields or the charge-density remains unaffected even when the creation of pairs is taken into account.*

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* The line of argument has been purposely avoided as it is too complicated to be put down here.

Science as a School Subject

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NOT many years ago students of science were despised as having forsaken culture for utility. Classics was regarded as the only possible course of study for gentlemen and, indeed, no man was supposed to be educated unless he had spent many hours mastering one or more dead languages. Slowly but surely that attitude is changing. There are still many conservative minds to whom the absence of classical languages from the curriculum condemns it beyond redemption. To such people education means having acquired by hard memorizing an elementary knowledge of the grammar, literature and structure of a dead language. That the actual knowledge acquired was insufficient in the majority of cases to enable the student to read with profit or pleasure books written in the tongue supposed to have been learned did not seem to matter. In times past if a man could quote from the classics he was supposed to be cultured. That he was profoundly ignorant of the meaning of the simple phenomena affecting his normal life was immaterial. He had sat at the feet of the ancients and was, therefore, fitted to walk proudly if ignorantly about the modern world. The supporters of classical studies claimed for it not only culture but a mental training more valuable than that to be obtained from the study of other subjects. The argument is no longer of really much importance. Mental training in one subject is now known not to be as easily transferable as was hitherto thought possible, and culture when accurately defined and understood is not now limited to particular subjects. There is a growing realization that a man must know the present world as well as the past and, indeed, that a knowledge of the former is even more important than acquaintance with the latter.

Nevertheless there still persists the belief that it is on the material and practical aspects of science subjects that their chief educational value lies. The object of this short paper is to stress their cultural and mental training aspects. Elementary science should find a place in the education of of every youth—boy or girl. Life consists of an interpretation of experience. Individual experiences differ but all experience normally includes the use of the senses—observations about the external world and an interpretation of events external to oneself.

An elementary knowledge of scientific laws makes for an understanding and an appreciation of the world around us. Why intellectual curiosity should be allowed and encouraged to wander amidst worlds long since vanished but should be lulled into unconsious oblivion when faced with the world of to-day has always seemed to me a mystery. Science properly taught and properly understood can give a greater stimulus to the intellect—a greater and more fruitful interest in life and a more adequate mental training than that of any other subject. On the other hand, it can be just as sterile as the dullest subject ever introduced into the school curriculum.

It is now generally recognized that for the normal student the real value of any teaching lies in the mental training that it gives. Subject matter is less important than method, and the acquisition of knowledge without understanding has little to commend it. In certain vocational subjects facts are obviously important but in the general education given to the non-specialized pupil what is most important is that he should be taught to generalize and think logically. General scientific method and elementary scientific knowledge should be taught to all.

In the class room, therefore, the science teacher must first make up his mind as to what is his object in teaching. It will help him to do this if he will pause for a moment and ask himself the question: "Of the class of 30 in front of me how many will ever need the knowledge that I am supposed to give them—how many will make any practical use of it?" The answer will probably be one, or at the most two.

SCIENCE AS A SCHOOL SUBJECT

Moreover, these two, as they will probably have to pass examinations in these subjects, could almost certainly acquire the necessary facts from text-books even if they were never taught in the class. I suggest that the teachers' real objective should be that of making each boy in the class understand the meaning of the simple laws that operate continuously in the world immediately around him. These laws should be the ones relating to human conduct as well as those operative in the material world. The incidence of those laws in his every-day life should be indicated by the teacher. The pupil should be made to feel that he is being helped to understand the world with which he is surrounded and while not every pupil will be interested in every aspect of the subjects taught, every normal boy or girl can be made to respond to some stimulus. elementary botany, physiology, biology, physics, chemistry, Astronomy are not abstract conceptions remote from every-day experience, they have obvious and strong contacts with our ordinary environment. But what arid, meaningless labour their study so often is. I have found honours science students able to reproduce difficult mathematical proofs but unable to answer an elementary question demanding a common-sense application of a simple law. The omission of science from the ordinary school curriculum and its being started as an examination subject at the intermediate stage has done untold harm to its teaching. Students under such circumstances never regard their studies as an interpretation of life-experience. We need the introduction of sciences as school subjects for the information that they can give, for the mental training that they can ensure, for the understanding of our natural environment that they can impart. A subject should never merely connote knowledge to be acquired for the passing of a test. Unfortunately science teaching in schools is not cheap. Its satisfactory teaching demands appliances and apparatus. An ingenious teacher can make some apparatus—the rest must be provided. Over and above this, there is demanded from the teacher an appreciation of the value of his subject and of the part that its teaching should play in the intellectual life of his pupils. Science teaching is in its infancy in this country. Now is the time to ensure that its growth is healthy and that it develops as a living subject.

The aspect that I have emphasized is that of the correlation of the knowledge with the actual lives of the pupils. The next and last point is that science should be taught as a science and not as a memory test. So conceived, it becomes not merely the foundation for more advanced studies in the main technical applications which are becoming economically increasingly important, but the most valuable of all subjects for developing logical thinking and powers of generalization. It is more important to teach understanding than to teach correct facts. A boy who understands why a thing happens will automatically remember what happens. Knowing that all substances expand when heated is of little value to most people – knowing why they expand is of great value. Science teaching should always be an exercise in reasoning and logical thinking, never a dreary repetition of meaningless facts.

Georg Wiegner (1883-1936)

J. N. Mukherjee

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AFTER a brief period of suffering following a major stomach operation, Professor Dr. Georg Wiegner died on April 14, 1936. He was a pioneer soil scientist, whose investigations particularly on the base exchange and other colloidal properties of soil are landmarks in the progress of soil science.

Wiegner was born on April 20, 1883, in Leipzig Germany, the son of Hermann Bruns Wiegner, keeper of a restaurant in Leipzig. Being the third of twelve children, young Wiegner had to bear more than his share of the family burden. He finished his early education in a 'Real' school in Leipzig and in 1902 he got himself admitted into the Leipzig University as a student of natural sciences. among his teachers in the University were persons of the eminence of Hantzsch, Beckmann, Wislicenus, Wiener. In 1904 Wiegner passed the chemical society examination of the University with distinction and during 1905-1906 worked on physico-chemical problems as an honorary assistant to Prof. Hantzsch. In 1906 he was promoted to the degree of doctorate by Profs. Hantzsch and Ley for his work on "the metastable conditions in the reactions between solid and gaseous substances." Wiegner could not stick to his honorary post in the University as he had to earn a living for himself and the family and in the summer of 1906 he joined an enamel paint industry in Zwickau as a working chemist. He was, however, always on the lookout for an opportunity to come back to pure science and in 1908, in spite of several tempting offers from the German Solvay Works, he took up an appointment as chemical assistant to the celebrated agricultural chemist, Prof. Fleichmann, at the Agricultural Institute of Georg August University, Göttingen. Here Wiegner worked on several important problems in agricultural chemistry as also on problems dealing with the physics and chemistry of milk. At Göttingen Wiegner came in contact with the celebrated colloid chemist, Zsigmondy, and this acquaintance formed a turning point in his career. Wiegner was won over to colloid chemistry. Zsigmondy's ultramicroscope captivated his imagination and he applied ultramicroscopic methods with conspicuous success in establishing a correlation between the physical and chemical conditions of milk and its state of dispersion. The principal subject of Wiegner's interest in Göttingen, however, was soil science.

In 1913 Wiegner took his appointment as professor (ordinary) of chemistry (special subject, agricultural chemistry) at the Federal Technical High School, Zürich, which post he held till the time of his death. Wiegner settled down permanently in Switzerland and here, at Zürich, he carried out most of his important investigations on soil science which earned for him an international reputation. At Zürich, besides soil science proper, Wiegner interested himself on problems relating to manures, fodders, chemistry of milk, and other food materials, and agricultural technology, and lectured extensively on these subjects. Wiegner had a particular fascination for the subject of human and cattle nutrition and when in 1925 the Swiss Department of Agriculture founded the Animal Nutrition Institute at Zürich, Wiegner, with his accustomed zeal, at once set out to work on nutrition problems. Under Wiegner's guidance important investigations on the various aspects of the subject of nutrition have been carried out in the institute.

Wiegner was pre-eminently a soil scientist. He recognized soils as disperse systems and believed that the laws of colloidal science should be applicable in the case of soils. He, however, realized the difficulties in the way of applying methods used in the study of pure colloids to a scientific study of the soil because of its complex character. For this reason Wiegner was always of opinion that investigations with judiciously chosen simple colloidal systems should serve as a guide to a study of the soil from the colloid chemical point of view. Today it is no exaggeration to say that the formation of the modern colloid chemistry of soil was laid by Wiegner at Zürich. As the results of twenty three years' patient work with clays, permutites, metal sols, humus and other colloidal systems Wiegner was able to make fundamental contributions to our knowledge of coagulation, base exchange, ageing, sedimentation, and other characteristic properties of colloids in general and soil colloids in particular.

Wiegner was the recipient of many honours and prizes. He was the corresponding, honorary, or foreign member of a number of learned societies including the Zechoslovakian Academy of Sciences, the Hungarian Academy of Science, the Royal Academy of Agriculture of Sweden, the Agricultural Chemical Society of Finnland, the Swiss Union of Analytical Chemists, and the International Congress of Soil Science. He was the president of the Soil Chemistry section of the Third International Congress of Soil Science. The Laura-R. Leonard prize of the Kolloid Gesellschaft was awarded to him for his work in the domain of the applications of theoretical colloid science. The Veterinary Medical Faculty of the University of Zürich conferred on him the honorary doctorate degree in recognition of his pioneer work on cattle nutrition. He was one of the two honorary members of the International Society of Soil Science elected at the Third International Congress at Oxford in 1935.

Wiegner had a retiring and amiable disposition. His retiring nature and devotion to soil science prompted him to decline several tempting offers from a number of scientific and industrial institutions. His students and collaborators now hold responsible posts in agricultural institutes in different parts of the world. Today, friends, admirers, colleagues and students all over the world mourn the loss of a man who though great in qualities of the head was also great as a man.

Notes and News

Animal Nutrition Institute

The Government of India have approved of the scheme for the establishment of an Institute for Animal Nutrition at Izatnagar. The Government of India have sanctioned for the Institute non-recurring expenditure of nearly Rs. 5,00,000 for the construction of buildings and road and for certain other capital expenditure, and an average annual recurring expenditure of nearly Rs. 100,000 from 1937-38 onwards for the entertainment of staff, etc.

The Institute will be under the administrative control of the Director of the Imperial Institute of Veterinary Research, Muktesar, and it has been decided that the Physiological Chemist's Section should be transferred, as soon as possible from Bangalore to Izatnagar, to form the nucles of the Animal Nutrition Institute.

The main functions of the Institute will be the study of nutrition in relation to the maintenance of health, normal growth and productive capacity of animals in India, and included in its main lines of work will be the analysis of important foodstuffs of India, digestibility and utilization experiments on foodstuff of all-India importance, investigation into the physiological significance of the inter-relation of foodstuffs, collaboration with agriculture on factors affecting the composition of foodstuffs, correlation of the nutrition work done at the Central Institute and at provincial centres, investigation into diet in relation to growth, milk production, work, wool production, production of hides and skins, and breeding problems, investigation into mineral and vitaminal requirements, collaboration with Muktesar regarding the influence of nutrition on susceptibilities to disease, investigations into basal metabolism and analysis of the pastures of typical grazing areas.

The Nutrition Institute will deal primarily with the effect of nutrition on animals, while the Muktesar Institute will deal with disease conditions arising from faulty nutrition whenever they arise.

The Institute will be organized into four sections, namely, Physiologcial, Bio-Chemical, Analytical, and Pathological.

Claims of competing places for the location of the Institute were considered in detail, and all things taken into consideration, the choice ultimately fell on Izatnagar. Considerations that weighed in favour of Izatnagar are that it is a centrally situated place with good railway communications with all parts of India, and that located here, the Institute itself will be within easy access of the Imperial Institute of Veterinary Research, Muktesar, where cognate research is being carried on, and which possesses the most complete Animal Husbandry library existing in India.

Radio Advisory Council

The Government of India have decided to establish an Advisory Council to assist the Controller of Broadcasting in the working of the Delhi Broadcasting Station. The Council will meet at suitable intervals, to be determined by the Controller, and will advise him on such matters as he may refer to it. The Council will select sub-committees to each of which the Controller will have authority to co-opt not more than two members if and when necessary, to deal with particular subjects, such as music, drama, language and the like.

The Council will at present consist of the following :—

President—Controller of Broadcasting; *Secretary*—Director, Delhi Broadcasting Station (ex-officio) : *Members*—Professor B. N. Ganguli, (Delhi University); Dr. S. K. Sen, (Medical Practitioner, Delhi); Pandit Haksar, (cloth merchant), Delhi; Mr. Shiv Raj Bahadur, (merchant, Delhi), Mr. Ghulam Mohammed (Posts and Telegraphs Department); Mrs. Asaf Ali; Mirza Mohammed Said (Delhi), the Hon. Raja Charanjit Singh (Member, Council of State), Sir Mohammed Yamin Khan, M.L.A. (Meerut), the Educational Commissioner with the Government of India (ex-officio), Lala Shri Ram (banker and merchant, New Delhi), Mr. Ram Kishore (Vice-Chancellor, Delhi University) and Dr. Zakir Hussain.

Abolition of Post-Graduate classes of the Agra University

Apropos to the *suggestion of the Government of* the United Provinces to the authorities of the Agra University that the post-graduate classes, with the exception of one or two subjects, be abolished in the colleges affiliated to the University, the Executive Council of the University is said to have recorded at its meeting held on August 7 last, its strong disapproval of the Government's suggestion. The abolition of teaching of post-graduate classes means doubtless a retrograde step, as pointed out by the Council. The Government has made the suggestion only "to avoid duplication of teaching and the waste of money as the keeping of a staff for a class of four or five students was not justified."

The Executive Council has decided, it is understood, to make a representation to the Government against their move advising the abolition of the post-graduate classes, as in its view such a step was very retrograde. The college authorities will probably be advised by the Executive Council, it is said, not to take any step on the Government's advice until the result of its representation.

The Agra College authorities, however, appear to have decided already to abolish from next year, perhaps in pursuance of the Government's advice, post-graduate classes in philosophy and economics. This impression has been caused by their giving one year's notices to the assistant professors in these subjects. An authoritative confirmation of such an action of the Agra College authorities is, however, not available.

Agra University Extension Lectures

The Executive Council of the University of Agra awarded six research scholarships, two in economics and four in science. It appointed Dr. Ishwari Prasad to deliver University extension lectures at Bikaner College, Prof. C. Mahajan at S. D. College, Cawnpore, and Prof. L. C. Dhariwal at St. John's College, Agra.

The Everest Expedition

Mr. Hugh Ruttledge again led the Everest expedition this year. The success attained in 1936 does not seem to be anywhere near that achieved in 1933, a year characterized by very bad weather. The despatches sent by Mr. Ruttledge from Tibet and published in the *Statesman* of the 27th and 28th July are extremely interesting.

According to Mr. Ruttledge the weather over the Everest region this year was good on the whole except for short spells of snow-fall.

In spite of the favourable conditions the fact remains that the expedition has failed. This is a paradox and it may be worthwhile to put the known facts together, *viz.*

(1) In February last the expedition left for the Everest with an optimistic forecast of good weather with certain cautions.

(2) On account of conflicting factors the Director-General of Observatories did not issue the long range forecast regarding the prospects of the monsoon this year.

(3) The February forecast noted above apparently held until the third week of May, when the monsoon was supposed to have approached the Everest with incredibly high speed.

(4) From the press reports we understand that the failure of the expedition was due to an early monsoon.

It is not easy for the public to ascertain the truth from a mass of conflicting statements. From the dates of spells of bad wether given in Ruttledge's despatches it appears that the intense cyclone over Saugor Island towards the close of May, which devastated East Bengal, is also responsible for the failure of the expedition. During this period the Everest had heavy snowfall but summer conditions returned giving rise to avalanches. This is the real cause of the failure of the expedition this year.

We sympathize with Mr. Ruttledge and his party in their gallant defeat, and hope that the great adventure will be taken up with renewed vigor in the future.

Grant for Rural Development

Last year the India Government placed a sum of Rs. 92.5 lakhs at the disposal of the local Governments and Minor Administrations for the purpose of rural development during the year 1935-36. An extra amount of Rs. 103 lakhs is available for the current financial year. The following statement shows how the amount will be distributed.

Province	Rural population (in millions).	Previous allotment (in lakhs of Rs.)	Proposed allotment (lakhs).
Madras	37.90	14	15
Bombay	13.79	7	5
Sind	3.19		3
Bengal	46.43	16	18
United Provinces	42.98	15	17
Punjab	20.51	8.5	8.5
Burma	13.15	5	5
Bihar	30.91		12
Orissa	7.80	12.5	4
Assam	8.41	5	5
Central Provinces	13.64	5	6
North-West Frontier Province	2.04	3	3
Delhi		.5	.5
Ajmer-Merwara		.5	.5
Coorg		.5	.5
Total		92.5	103

Health of Bombay Students

In these columns we have often referred to the health of Indian students. It is an important problem and has only recently attracted some attention. Below we give some facts regarding the health of students in the Bombay Presidency as revealed in the annual medical examination report of the Bombay University.

Students were classified into three classes A, B, and C according to the condition of their health. C class students were supposed to be no good for physical training and improvement, owing to some organic disease.

The number of students examined and analysed during the year was 12,370, lady students numbering 1,135.

The number of students in the different categories was as follows :

A class 6,114; B class 6,026; and C class 234.

The report states that in the Sind group the weight of the students was quite good, but their physical development was poor. On the other hand, in the Deccan group the students had good muscles but they were put into the 'B' class, because their weight was not up to the standard owing to the low food value of their diet.

The Gujerat group showed very poor physique, the students are either too fat or too lean. It may be due to eating fatty food, taking no exercise or eating too many vegetable salads, having no food value as regards the building of muscular tissues. In addition, they seem to have no desire to improve their physique, which needs regular exercise.

The Karnatak college group showed a large proportion of students in class A. They have a very good physique, the percentage of A class students being above 67 per cent. in Karnatak College and 52 per cent. in the college at Belgaum.

LADY STUDENTS

In regard to the physical build of lady students in the mofussil colleges, the report says : "The chest expansion among them is very poor, indeed, unless some mistake has been made in taking these measurements. If they are correct, it is high time that some physical drill, needing chest expansion and free breathing exercises for at least a quarter of an hour per day, was made compulsory for them. Both in Gujerat and Sind this deficiency in chest expansion was to be particularly noticed.'

The report further states that the students seem to have a desire to improve their physique. It was the duty of medical examiners to encourage that attitude. Students needing treatment for eye diseases were 2,152, nearly 16 per cent. of the number examined.

In the number of A class students Karnatak College stands first and the Gordhandas S. Medical College, Bombay, the Grant Medical College, Bombay, and the Royal Institute of Science, Bombay, stand second, third and fourth, respectively.

Geiger Institute

The newspapers of Munich announce that the German Academy has decided to establish a new Research Institute under the name of 'Geiger Institute' to commemorate the 80th birthday of Prof. Wilhelm Geiger, which fell upon the 21st July. The aims and objects of the Institute are mainly to continue the numerous researches to which the German professor has devoted most part of his scientific career. The subjects in question cover a large field involving both Ceylon and India.

A representative Board of Advisers and an authoritative Committee of Management will be eventually appointed under the direction of Prof. Dr. Wust, Dean of the Faculty of Philosophy in the Munich University. De Lanerolle, a pupil of Prof. Geiger's as well as of Baron Sir Jayatilaka of Ceylon, in co-operation with the authorities of the Deutsche Akademie, will organize the Institute. A complete plan of work will be announced in the due course.

It is hoped that various authorities in Ceylon as well as in India will take an active interest in the project.

Petrol from Coal

Production of petrol from coal by chemical methods is being encouraged by government in several European countries. As yet this petrol cannot quite compete with the natural product commercially. But it is likely to be very useful during a war when foreign supply of petrol may be in danger. The I. C. I. of Great Britain are running a huge plant under state patronage.

Further progress towards the widespread production of synthetic petrol from French coal has been made by the opening at Lievin of a second oil-from-coal works. The two factories now in operation are capable of treating 50 tons of coal a day and producing 10,000 tons of petrol a year. The method used is the hydrogenation of coal by a new process. A mixture of equal parts of coal and heavy oil is first of all hydrogenated under heavy pressure at 840 degrees Fahrenhiet. This yields medium oil and heavy oil and a small quantity of petrol. The medium oil is then again treated at a temperature of 930 degrees Fahrenhiet and is transformed into petrol.

U. S. S. R. and Rural Electrification

Electricity is being extensively utilised for farming operations in the Zaporozhye district, near the great Dnieprostroi hydro-electric station. This is the first area in the Soviet Union in which all agricultural operations are performed with the aid of electricity. Last year the local collective farmers threshed their entire grain harvest by this means, according to the "Monthly Review" for June of the U. S. S. R. Trade Delegation in Great Britain. An electric threshing machine threshed up to 40 tons daily, while before the use of electricity the highest amount threshed was 25 tons a day. This enabled the collective to economize over a period of 27 threshing days to the extent of one man's 805 working days and 3,075 roubles in money. Because of the considerable savings in labour, time and money, farmers throughout the Soviet Union are beginning to make wide use of it. The electric plough has proved particularly valuable in preparing the land for the planting of the grape vines. Deep ploughing is essential for the successful cultivation of grapes, and it has been found in Zaporozhye that electric ploughing is easy even at a depth of a metre. Electric ploughs have also made their appearance in the older vineyards of Georgia and Armenia. Farmers are finding that the use of electricity reduces the cost of vegetables and increases the crop. Electric milkin increases the yield and enables the milkmaid who previously milked eight cows by hand to milk 20 cows very efficiently. The number of deaths of young animals has been greatly decreased by the use of electric heating in cow byres.

—*The Electrician*, July 10, 1936

Mr. Bruty on Electric Charges

The tenth annual conference of the Electrical Contractors' and Allied Associations was held at Folkestone on July 8, 9, and 10, and it was considered as one of the most successful gatherings of its kind yet held. In the course of his presidential address Mr. A. G. Bruty remarked." Had I the power I would immediately make the (electric) supply authorities concentrate their energies on their own work of providing a universal, cheap and abundant supply of electricity, without irritating conditions, without meter rents and charges of bringing in supplies. I would refuse to permit the making of wiring regulations to suit particular fads and fancies, and generally see that these monopolist authorities acted as if they were public servants giving a public service, and not dictators distributing favours." We have already dealt several times in these columns on the urgent need of the reduction of the exorbitant rates of electric consumption charged by the supply companies in this country. The remark of Mr. Bruty, quoted above, refers to Great Britain, where the charges of electricity are exceedingly low compared to what they are in India. If public consumption is greater there, it must be remembered that reductions in charges must precede and not follow an increase in consumption by the public. If the charges are such as to suit all pockets, we have not a manner of doubt that we shall see the whole country electrified at no distant date.

Reduced Telephone Charges in Great Britain

The Post-Master-General of Great Britain, Major Tryon, announced, in the House of Commons on July 18 last, considerable reduction in telephone charges, with effect from October 1 next. The Post Office has adopted this progressive policy, encouraged by the results of similar reductions in the past. From October, the first 50 local penny calls (or their equivalent) per quarter made by residential subscribers on a quarterly basis will be given free of charge, and the first 16 local calls in a month will be given free to ordinary monthly residential subscribers. Further, rentals for residential lines fitted with a coin box will be reduced by 2s. 6d. a quarter, and those for ordinary business and small business users are also to be cut by a similar amount. From January, rentals for private telephone lines will be considerably reduced. The cost of these concessions in a full year will be, it is estimated, £1,000,000 after allowing for growth of traffic, bringing the total cost of reductions in charges introduced in 1936 to about £1,500,000. Major Tryon said that the number of telephones was now increasing at the rate of 200,000 a year, and that during last year the number of calls increased by about 140,000,000 or more than 8 per cent. Commenting on these reductions, the *Electrician* says: "We derive particular pleasure from the success which has attended the recent policy of the Post Office, having consistently advocated such action in days when the official attitude was that reductions in charges must follow, and not precede, an increase in the use of the telephone by the public. Our contention that the only way to popularize the telephone was by lowering the cost, and that any initial loss due to cheaper rentals would be speedily made good has been abundantly justified." We draw the attention of the public, the public supply companies of this country, and the Government to the above views of the *Electrician*, which entirely correspond to those of ours, as expressed several times in these columns, commenting on the exorbitant rates charged by the public supply companies in India.

Recent Progress in Medical Science

The effects of alcohol on which medical scientists agree have been summed up in a recent book by Prof. Haven Emerson of Columbia University as follows; 1. Alcohol is a narcotic which by depressing the higher centers, removes inhibitions. 2. Outside of the nervous system and the digestive tract, alcohol used as a beverage has little demonstrable effect. 3. It is a food, utilizable as a source of energy and a sparer of protein, but it is such only to a very limited degree. 4. It is improbable that the quality of human stock has been at all injured or adversely modified by the long use of alcohol, although the effects on the individual are often devastating. 5. The therapeutic usefulness and value of alcohol is slight. 6. It may be a comfort and a psychological aid to the aged. 7. It does not increase, and it sometimes decreases, the body's resistance to infection.

Cobra venom, in doses too small to be poisonous, relieves pain as effectively as morphine. But the venom of the death-dealing serpent is not habit-forming when given to relieve pain, as morphine is, and it does not produce the disagreeable and dangerous by-effects of the narcotic drug. Experiments with cobra venom on laboratory animals and human patients, including a hundred sufferers from cancer in its late stages, were reported by Dr. David I. Macht, Director of Pharmocological Research Laboratory, Hynson, Westcott and Dunning, Baltimore, at the meeting of the National Academy of Sciences.

That bone formation is an ever-changing process in the body and not occurring only during youth is suggested by experiments just reported by two Danish scientists.

Maternal instinct in young rats is due to the influence of prolactin, pituitary gland hormone, and can be aroused in young virgin rats by injections of this hormone (Drs. Oscar Riddle, Ernest L. Lahr and Robert W. Bates, Carnegie Institution of Washington.

Important aid for the treatment of liver disease and for preparing patients suffering from fatty livers for operation was the discovery by Drs. J. L. Bollman and F. C. Mann, Mayo Clinic, that the composition of the liver can be varied within wide limits by diet.

Removal of all but a small portion of the frontal area of the brain with no impairment of intelligence in the patient, but increased concentration, was the result of an operation performed by Dr. Glen Spurling, University of Louisville, and reported by Dr. S. Spafford-Ackerly.

---*Journal I. M. A.*

British Fishing Boats

A Special Exhibition of Models and Plans of British Fishing Boats was opened at the Science Museum, on July 22nd, by the Lord Macmillan, K.C. The introduction of the marine motor is bringing about the rapid extinction of the grand old types, which are now being superseded by modern motor craft, built to a few comparatively standard designs. The fact is certainly not generally realized that until within the last few years, there were no less than two hundred distinct types of fishing and coastal craft surviving in the British Isles, after centuries of evolution had brought them to their final form. Yet before long the majority of these will have gone for ever, and the brown sail of the fisherman will be no longer seen. Of 300 Brixham trawlers, for example, surviving after the Great War, not a dozen of the First Class remain. Of 800 Humber sailing trawlers in the late 19th century, not one is left to-day.

Among the 120 models and plans shown, which occupy the whole of the Exhibition gallery, are specimens of craft from all coasts of the British Isles, including Orkney and Shetland; representing both sailing and rowing boats, and types used for every kind of fishing. In addition to the plans and models of craft still in existence, there are also some of craft long extinct.

Owing to local conditions, influences and traditions there are wide variations of design among these craft; very much wider, perhaps, than the layman appreciates; and this is clearly seen in the Exhibition. Some, like the Shetland "Sixerns", have followed in unbroken tradition upon the Norseman's long-ship: others, like the Deal Luggers and the Falmouth Quay-punts, provide a link with the heyday of the Sailing Ship, when their lines were determined largely by the local need for tenders to carry out stores to the larger vessels. All were affected by the local conditions in which their work was done; whether to launch from an open beach, like the Yorkshire Cobles, or the Portland lerrits; or to work from small pier harbours, like the famous Mount's Bay or Penzance luggers.

In craft used for fishing, the design would depend on the kind of fishing for which they were to be used; whether for drift-net, trawl, line-fishing, or any other method.

Realizing the danger that these old types would disappear before full information could be secured, the Society for Nautical Research appointed a Coastal and River Craft Sub-Committee in April, 1934, to organize a survey of the British Isles. With the aid of a fund of £500 now being raised, to which the Pilgrim Trustees generously granted £250, draughtsmen are now being employed in taking off the lines of all surviving coastal craft, from which such complete plans are being made that full sized replica, or a perfect model, could be made at any future time. In addition, the voluntary assistance of yachtsmen has been organized through the yacht clubs, for the collection of every scrap of information, and of photographs, so that the history of the craft can be preserved.

The Exhibition contains the results of the first two years' research, and shows the most complete collection of plans and models of British fishing boats and other coastal craft that has ever been seen. Of old timers, there are, for example, a contemporary drawing of English Fishing Boats about 1650 the lines of hoy of 1717; and a Tewey Smuggler of 1805. Of later years, there are fine models of Humber and Brixham trawlers, a Galway "hooker", a Scottish "Zulu", a "scaffie-yawl", and many others. The plans are arranged on lecterns, and wherever it is possible, models and plans of the same type of craft are arranged together, making a very interesting comparison.

NOTES AND NEWS

Marketing of Sugar

At a meeting of various sugar-mill-owners, quite a large number of whom were present in Calcutta on the occasion of the fourth annual general meeting of the Indian Sugar Mills Association, it was decided to form a Sugar Marketing Organization. It is expected that all the sugar of the various sugar factories joining this scheme will be marketed through it. This central marketing company, however, would not disturb the present selling and distributing arrangements of sugar viz., the dealers and agents but would utilize all these channels for the purposes of marketing. Prices of sugar would, however, be quoted by this organization and not by individual factories. A large number of mill-owners have already agreed to join the scheme and with this preliminary start, it is expected that the central marketing scheme will prove a success. Other member factories of the Association are being approached to join the scheme.

Indian Central Cotton Committee

The appreciation of the Indian Central Cotton Committee of the work done by the Lancashire Indian Cotton Committee to increase the use of Indian cotton in the United Kingdom was expressed by members of the Committee at its 33rd half-yearly meeting held in Bombay on the 17th and 18th of August 1936 under the presidency of Sir Purshotamdas Thakurdas. His Excellency the Governor of Bombay formally inaugurated the meeting. The question of wider markets for Indian cottons received the special attention of the Committee which devoted a considerable portion of its time in discussing the report of the Special Sub-Committee appointed to deal with this matter.

The Committee expressed its satisfaction at the passing by the Bombay and Central Provinces Governments of legislation for the control of cotton ginning and pressing factories designed to prevent such malpractices as excessive watering, the mixing up of different kinds of cottons etc. The Committee was confident that the new legislation will prove of great benefit to the cotton industry of India. The Committee urged on the Government of Sind the necessity to take early steps to make the Cotton Ginning and Pressing Factories Amendment Act effective in that province by framing rules as early as possible. It was revealed that 67 Indian States had now enacted legislation on the lines of the Cotton Ginning and Pressing Factories Act of British India and from 60 States weekly press returns were being received.

A further step was taken in the policy of establishing regulated cotton markets when the Committee endorsed the view of the Bombay Government regarding the establishment of 2 more cotton markets at Broach and Bavla in the Ahmedabad district under the Cotton Markets Act.

The Government of the United Provinces had submitted to the Committee the draft of a proposed measure for the control of pink boll-worm pest of cotton which has been responsible for causing heavy damages to the cotton crop of the United Provinces.

The report of the Cotton Forecast Improvement Sub-Committee on studies of village consumption of cotton, post-mortem examination of cotton forecast of 1934-35 season, publication of monthly statements of cotton pressed in Indian States and the progress report of the Bombay Cotton Crop Forecast Improvement Scheme for 1935-36 was approved and adopted.

The Committee approved the report of the Agricultural Research Sub-Committee and expressed its satisfaction at the progress made by the 29 Agricultural Research and 13 Seed Distribution Schemes financed by the Indian Central Cotton Committee.

In pursuance of the policy of improving the quality of Indian cotton the Committee approved of a number of new research schemes including a scheme for breeding wilt resistant cottons for Surat area, scheme for the improvement of Dholleras cottons and a scheme for the improvement of Kumpta cotton in the Hyderabad State. The Committee also sanctioned the extension of several cotton breeding, propaganda, estomological and seed distribution schemes. In particular the work on cotton wilt breeding centralized at Poona was appraised by the Committee as being of fundamental importance and the Committee recommended that this work merits extension without any charge being made on the Bombay Government.

The report of the Technological Research Sub-Committee was approved. The report showed an increase in the total number of samples received at the Technological Laboratory for yarn testing and this clearly indicated the increasing popularity of the work done by the Laboratory. The report contained the results of tests carried out at the Laboratory with a view to ascertaining the influence of density of compression on the spinning quality and waste losses of Indian cottons and it was decided that these results should be published in order to elicit the opinion of the trade. The progress reports of the Director, Technology Laboratory, and the Publicity and Propaganda Officer were approved and the Committee's appreciation was recorded of the valuable work done by both officers in their respective spheres. Successful results achieved in connection with the anti-Gogliari propaganda campaign in Surat and Baroda districts, campaigns for the extension of cotton on the Indus Right Bank areas and the extension of Pink Boll-Worm control measures in the United Provinces were specially mentioned.

The committee was gratified to note the satisfactory progress made by the Institute of Plant Industry, Indore. The annual report of the Director of the Institute was approved and the Committee expressed its satisfaction on the vast amount of work carried on during the year ending 30th June 1936.

Award of the Industrial Research Bureau

The following awards have been made by the Industrial Research Bureau:

	Rs.
1. Manufacture of Photographic Plates in India.—N. Kashinathan, M.A., M.SC., Calcutta	1,000
2. Process for the Preparation of pure Al_2O_3 and SO_2 gas from Bauxite-Gypsum Mixtures.—(*a*) Dr. V. S. Dubey, M.SC., Ph.D., Benares; (*b*) Professor M. B. Rane, M.A., Benares; and (*c*) M. Kanakaratnam, M.SC., Benares	500
(3) Utilization of Nepheline Syenite Rock.—(*a*) Dr. V. S. Dubey, M.SC., Ph.D., Benares; (*b*) P. N. Agrawala, M.SC., Benares	250
4. Losses on Electrical Machinery due to Open Slots.—Kenneth Aston, B.SC., *Tech.* M.I.E.E., Bangalore	250
5. Aromatic Resources of India.—Sadgopal, M.SC., Benares	150
6. Saponification of Mahwa Oil.—R. K. Gobhil, B.SC., A.H.B.T.I., Cawnpore ..	150
7. A New Process for the Solvent Extraction of Castor Seed with Rectified Spirits.—Dr. N. G. Chatterji, Cawnpore	150
8. The preparation of New Wetting Agents.—(*a*) K. Venkataraman, M.A., Ph.D., Bombay; (*b*) D. R. Dhingra; and (*c*) I. S. Uppal, Bombay	150
9. Cashew Nut Shell Oil and its Utilization.—N. M. Patel, Bombay	150

Magnificient Gift for Reseach

Soon after the announcement of the magnificient gift of a quarter million pounds by Sir Herbert Austin to the Cavendish Laboratory, Mr. Frank Parkinson of Messrs. Cromptom Parkinson Ltd. has offered to the University of Leeds a sum of £50,000 towards the establishment of a scholarship endowment fund. In order that scholarship grants may not be delayed pending receipt of interest from the fund in the first year, he has further offered £1,500 for granting scholarships in the first year. In his letter to the vice-chancellor of the Leeds University Mr. Parkinson says that in making this offer he is above all things anxious that it should fructify in the development of those types of manhood and womanhood which the country needs if it is to hold its place among the nations in the strenuous days ahead. He adds that *as an industrialist he is fully conscious of the service* which the study of pure science and the arts can contribute to the public weal.

Poultry Reseach Institute

An *Associated Press* message states that the Government of India have approved the scheme for the establishment of a Central Poultry Institute at Izatnagar under the administrative control of the Director of the Imperial Institute of Verterinary Research.

They have sanctioned a non-recurring expenditure of nearly Rs. 2,75,000 for buildings, roads and other capital expenditure and an average recurring expenditure of nearly Rs. 56,000 a year form 1937-38.

The Institute will carry on research on disease, nutrition and genetics of poultry and also act as a bureau of information for other intsitutions. It will also carry on investigations on processing and disposal of poultry and egg products and make arrangements for courses of training if there is any demand.

Selective breeding work will, however, remain a provincial subject.

Rebuilding of Quetta

After his investigations at the site of the last Quetta earthquake Mr. W. D. West of the Geological Survey of India has come to the conclusion that Quetta is probably the safest place in Baluchistan in which to build houses. Mr. West, who is also the secretary of the Seismological sub-Committee of the National Institute of Sciences and the President of the Geology section of the Indian Science Congress this year, lays great stress on scientific construction of buildings to minimize disaster in case of a future earthquake. We give below some extracts from Mr. West's report.

Commenting on the Quetta earthquake itself Mr. West says: "The major part of the destruction in the city was due to two causes, inferior construction and the height of the buildings. Another factor which must have increased the motality in Quetta city was the narrowness of most of the streets, making it impossible for people who did have time to escape to reach a place of safety. A most unsatisfactory detail in the construction of many buildings in Quetta was the incorporation of wire netting within the plaster of the walls.

"During the earthquake this came down accompanied by a suffocating cloud of dust, and it proved a death trap in numberless cases, making it impossible even for those who were not seriously injured to escape out of their ruined houses. It also proved a great handicap to those engaged in rescue work.

"It is generally accepted that buildings, if they are to resist, earthquake which may come from any direction, should be built as squarely as possible. That this is essential received confirmation from the destruction wrought in the R. A. F. lines. Here, the single men's quarters were built in long lines, which were aligned more or less at right angles to the direction from which the shock came. During the earthquake they simply went over sideways, and incurred a high mortality. On the other hand, the married men's quarters were more compact, square-shaped houses; and although they were seriously cracked, they did not collapse and no one was killed.

"Perhaps the most difficult problem in the rebuilding of Quetta is going to be adequate supervision. That this has not been successfully accomplished in the past is clear from the damage sustained by comparatively new buildings which should have been carefully constructed. The Ammunition Depot is a case in point. It was a building which required perhaps more careful attention in construction than any other building in Quetta, and yet its outer walls collapsed at the beginning of the shock, largely through the quality of the mortar employed.

"It is well known that the banks of streams tend to collapse towards the stream during an earthquake. So considerable is this tendency that it is often the chief factor in the damage to bridges. This was well demonstrated in the case of many bridges around Quetta.

"While this indicates that special attention must be paid to the abutments of bridges in areas liable to earthquakes, it also indicates that the immediate neighbourhood of streams is an unsafe place in which to build houses.

"Another position of danger during earthquake is the junction of solid rock and alluvium. In the Mastung-Kalat valley, those villages of the valley at the junction of the 'pat' and the hills were generally more severely affected than villages situated more centrally in the valley. It is possibly due to the fact that the solid rock and the alluvium vibrate with different periods during the earthquake.

"It having already been indicated that probably the safest place in Baluchistan in which to build now is Quetta, it remains to consider which part of Quetta is least liable to the effects of earthquake shocks. It is of course impossible to predict where the epicentre of the next earthquake is going to be, or even on which side of Quetta it is likely to occur. But I consider that other things being equal, for the reasons given above, future earthquakes are always likely to affect the lower and more South-westerly part of Quetta to a greater extent than the higher north-easterly part."

Mr. West suggests the careful drawing up of a building code to ensure safe constructions, since the destruction in Quetta was largely due to the inferior construction of the buildings. And since "the temperament of the average Indian builder inclines him to take risks by economizing at the expense of safety it seems probable that another similarly built city will eventually spring up and become another source of danger unless steps are taken to control the building."

The enforcement of such a code will not only ensure that such new buildings as are constructed will be reasonably proof against earthquakes, but it will very considerably restrict the size of the new city, since only those who are prepared to go to the necessary additional expenditure would build in Quetta.

It would therefore be essential to prohibit the use of a mud mortar. Houses of more than one storey should generally be prohibited, the plan of every building should be submitted to a competent authority, the width of streets should be not less than the combined height of the houses on either side, etc. etc.

Golden Jubilee of the Allahabad University

The University completes its 50th year on November 16, 1937. The council appointed a committee of nine members to consider preliminary plans for the celebration of the golden jubilee. Among the members of the committee appointed are the Rt. Hon. Sir Tej Bahadur Sapru, Mr. I. N. Gurtu, the Vice-Chancellor, Pandit Amarnath Jha, Rai Bahadur Pandit Kanahiya Lal, Dr. Tara Chand, and Dr. Rice.

Discussions and Symposia at the next Science Congress

It has been proposed that discussions and symposia on the following subjects may be arranged at the next Session of the Indian Science Congress Association to be held at Hyderabad in January, 1937, provided the proposal receives sufficient support. Members of the Science Congress interested in the proposal are hereby requested to get into touch with the Sectional President whose name is mentioned against the subject for discussion in the following list:

I. On Wegener's Theory of Continental Drift as regards India and adjacent Countries. (Joint Discussion—Geology, Zoology and Botany Sections).	Mr. W. D. West, M.A., President, Geology & Geography Section, Geological Survey of India, 27, Chowringhee, Calcutta.
II. On the need for a Soil Survey for India. (Joint Discussion—Geology & Agriculture Sections).	Ditto.
III. The Age of the Deccan Trap. (Geology Section only).	Ditto.
IV. On Nutrition in Relation to Crops as well as Human Beings and Farm Livestock. (Joint Discussion—Medical and Veterinary Research, Physiology, Agriculture and Chemistry Sections).	Col. A. Olver, C.B., C.M.G., F.R.C.V.S., President, Medical and Veterinary Research Section, Animal Husbandry Expert, Imperial Council of Agricultural Research, New Delhi.

Research Notes

Prehistoric Archaeology in Indonesia

In the *Annual Bibliography of Indian Archaeology for the year 1934*, Dr. Robert Freiherr von Heine-Geldern contributes an article on the above subject. He draws our attention to the recent discoveries of some human skulls on the terraces of the Solo river near Ngandong (Java), definitely belonging to the Pleistocene Age and nearly akin to the Neanderthal man. Most of the palaeolithic implements, however, belong to the present geological formation, and may be ascribed to any one of the three groups; (1) hand-axe cultures, related to similar cultures of Malay Peninsula, Siam and Tonkin; (2) flake cultures which are spread over the Irrawaddy basin in Burma. 'The original home of all these flake cultures of South-East Asia may have been in India, where the later stages of the palaeolithic are full of similar civilizations.' These may be affiliated to the Weddoids and partly to the Negritos; (3) a bone and horn culture, probably of North Asiatic origin.

The neolithic cultures are grouped under the following heads: (1) the first, developed out of the hand-axe culture through the influence of neolithic elements; (2) the second, the existence of which is known from stone arrow-heads, probably imported from Japan through the Philippines; (3) the third, characterized by stone knives, points of stone etc., also probably from Japan; (4) earlier shoulder-axe culture, probably connected with the local palaeolithic culture; (5) round-axe culture, which reached Eastern Indonesia by way of Formosa and the Philippines; (6) quadrangular axe culture, which came from China through Further India probably between B.C. 2000 and 1500 and includes the megalithic culture of Indonesia; (7) the primitive Polynesian civilization, a branch of the quadrangular axe culture.

A. Ghosh.

Correlation between Scattering and Recoil in the Compton Effect

Shankland's experiment on the scattering of γ-rays from RaC has been reported in the April issue of this journal. The results obtained in this experiment are incompatible with Compton's theory of scattering. The Shankland-experiment thus contradicts the earlier experiments by Bothe and Geiger, and by Compton and Simon, and thereby points to a breakdown of the conservation of energy and momentum in such atomic processes. The theoretical physicists like Dirac, Peierls, have later on drawn from this experiment important conclusions as to the tenability of the conservation laws. A report of these has also appeared.

Very recently, the Bothe-Geiger experiment has been repeated again by Bothe and Maier-Leibnitz,[1] and by Jacobsen[2] under very well-defined conditions. The results obtained by them are not in agreement with the conclusions of Shankland's experiment, but are in harmony with the existing theory. Jacobsen used the more homogeneous γ- rays from RaTh and applied a single counter for the detection of the scattered quanta and another for the recoil electrons. He also counted the number of so-called chance-coincidences. For this purpose, a lead sheet was interposed between the scatterer and the β-ray counter, while the fall in the number of single kicks was made up by a weak source of RaD placed near it. His results, corrected for these chance-coincidences, show that correlation exists between the β-, and γ-ray counters and their net number of coincidences agrees, in the order of magnitude, with that roughly estimated on the theory.

Bothe and Maier-Leibnitz[3] have carried out similar experiment with similar results. In their experiment, the filtered γ-rays from Th C″ were chosen on account of their greater homogeneity. A thin walled Geiger-Müller counter received the recoil electrons, while there were two connected lead counters for the scattered photons. The counters were placed symmetrically on both sides of the primary beam and their azimuth was 180°. It was found that the coincidence was very prominent when the angle with the primary beam was 30°, as expected on the theory, for both the β-rays and the γ-rays. The number fell down abruptly, when either this angle was altered, or when the azimuth was 90°; but in either case, it was higher than the zero-effect (i.e. coincidences due to chance). In order to count the number of these chance-coincidences, the scatterer was removed and the β-counter was exposed to a weak source of β-rays to maintain in it the previous rate of counting.

The results of these latest experiments were discussed by physicists like Bohr, Pauli, Fermi, and Heisenberg in a recent conference at Copenhagen. They have welcomed these results as they are of the opinion that all these atomic quantum processes can be explained on the conservation principles. Bohr[4] has given his views on 'Conservation laws in quantum theory'. He emphasizes that as the fundamental relations between the wave and corpuscular nature of matter and radiation can be expressed in accordance with the principle of relativity, the foundations of the quantum and the relativity theory cannot be inconsistent with each other. He is thus not prepared to dispense with the conservation laws, as urged by Dirac, in formulating the relativistic quantum dynamics. According to him, the difficulties in adapting the quantum Electrodynamics to the unsolved problems may lie in the "atomistic nature of electricity, which is as foreign to classical physical theories as the quantum of action itself". He is confident, therefore, that the doubts regarding the validity of the conservation laws, as suggested by Shankland's experiment, are entirely removed, and the Photon theory is confirmed in every way.

1. *Göttingen Nachr.*, *2*, 127, 1936.
2. *Nature*, *138*, 25, 1936.
3. *Phys. Rev.*, *50*, 187, 1936.
4. *Nature*, *138*, 25, 1936.

P. C. Mukherji.

On the discovery of a Kamboja dynasty of Bengal

In a very interesting communication entitled "Irda copper plate of the Kamboja king Nayapâladeva" (*Epigraphia Indica*, vol. XXII, pp. 150-59, 2 plates, 1936) Mr. N. G. Majumdar, M.A., F.A.S.B., Superintendent of Eastern Circle, Archaeological Survey of India, has edited a copper-plate, which proves, for the first time, the existence of a *Kamboja* dynasty in south-west Bengal in the latter part of the 10th century A.D. This copper-plate belongs to the zemindar of Irda in the Balasore district of Orissa. At present it is not possible to ascertain its actual find-spot and the circumstances under which it was discovered. In this copper-plate is mentioned king *Râjyapâla*, an ornament of the *Kamboja* clan (*kamboja-vamśa-tilaka*), whose queen was *Bhâgyadevi*. She gave birth to a son *Nârâyanapâla* who succeeded his father. *Nârâyanapâla* was succeeded by his younger brother *Nayapâla*. The object of this copper-plate is to record the donation, by the king *Nayapâla*, of the village of *Brhat-Chhattivannâ*, adjoining to *Kanti*, *Sammâsha* and *Bâdakhanda*, within the *Dandabhukti mandala* of the *Varddhamâna bhukti* on a *navamî* day in the month of *Kârttika* to the *Pandita Aśvatthaśarmman*, the son of the *upâdhyâya Anukulamiśra*, grandson of the *upâdhyâya Prabhâkaraśarmman* and great-grandson of *Bhatta Divâkaraśarmman*. This donation was recorded on the 18th Kârttika in the 13th regnal year of the king *Nayapâla*.

The learned author has very ably pointed out the importance of this copper-plate. He rightly holds *Râjyapâla*, *Nârâyanapâla* and *Nayapâla* cannot be made identical with the kings having similar names and belonging to the *Pâla* dynasty of Bengal. In the first place, their order of succession is altogether different. Secondly, *Râjyapâla* of this record has the epithet *Kambojavamśa-tilaka*, i.e., "an ornament of the Kamboja clan" but in the *Râmacharitam* of *Sandhyâkara Nandi* the *Pâlas* are supposed to have descended from the "*samudra-kula*" and in the Kamauli grant of *Vaidyadeva* are referred to as belonging to the solar race (*mihirasya vamśa*). Thirdly, nowhere the *Kamboja* origin has been attributed to the *Pâla* rulers of Bengal. From the palæographical evidence he has further shown that the *Kamboja* occupation of some parts of Bengal, referred to in this copper-plate and in a pillar-inscription found at Bangarh, is to be attributed to the 10th century A. D., i. e., to the period before the accession of *Mahîpâla* I. Regarding the problem of the *Kamboja* occupation of Bengal he has referred to some late literary evidence which proves the authenticity of *Kamboja* occupation of north-eastern India. It seems that this problem should be more thoroughly studied by some enthusiastic Indologist.

As regards the identification of the localities mentioned in this record it should be specially noted that we know, for the first time, from this copper-plate that *Varddhamâna-bhukti* had a *mandala* called *Dandabhukti*. This information confirms the view of the late Prof. R. D. Banerji that *Dandabhukti* was situated in the south-west of Bengal and is to be identified roughly with Midnapur and Balasore districts. According to the author *Brhat-Chhattivannâ* is to be identified with a place called

Chhatina on the *Suvarna-rekhâ* between Belyabera and Nayabashan. *Priyangu*, the capital of this royal family, remains unidentified.

C. C. Das Gupta.

Morphology and Embryology of Fouquieria

Johansen, Donald A. *Amer. Jour. Bot.*, *23*, 95—99, 1936.

The genus *Fouquieria* belongs to the family Fouquieriaceae included under the order Tamaricales of Hutchinson. Three species were investigated: *F. splendens*, *F. peninsularis* and *F. burragei*. The development of the embryo sac proceeds according to the *Adoxa*-scheme (the old "*Lilium*-type") but all 8 nuclei are formed only in *F. splendens* and here also in less than 50% of the cases. Usually only one of the four megaspore nuclei (a micropylar one) divides further and forms the two synergids. The third nucleus gives rise to the egg, while the two chalazal fuse to form the secodary nucleus. In *F. splendens*, 6-nucleate embryo sacs also occur, arising from the division of both the micropylar nuclei of the 4-nucleate stage, but some of these were found to contain no egg cell. The presence of a large haustorial arm and a cap-like epistase is common to all three species. Fertilisation and development of the embryo, both entirely normal, are described in detail.

The condition reported by Dr. Johansen is of very great interest but recently Dr. J. Mauritzon (1936) of Lund has also studied one of these species (*F. splendens*) and he reports a normal embryo sac arising from the lowest megaspore of a tetrad. Such an important difference between individuals of one and the same species *is possible but not very probable*. It is desirable that both of these investigators study the plants afresh and find out the cause for the discrepancy.

P. Maheshwari.

Toxin in Badly Stored Rice

Use of rice stored up in dark dingy godowns in the hot humid atmosphere of Calcutta during the rainy season is said to be responsible for the prevalence of epidemic dropsy amongst the rice-eating population of the city. N. M. Basu and S. R. Mitra, (*J. I. C. S.*, *13*, 255, 1936) have carried out an interesting piece of research in studying the effect of heat and moisture on milled and *Dhenki*-hulled rice side by side. Rice was kept in an incubator at 92°F in an atmosphere saturated with moisture. It was found that amino-nitrogen *in milled rice increased considerably during* the experimental period and that there was growth of some organism in it, whereas in the *Dhenki*-hulled rice there was no such organic growth and there was only very little increase in the amino-nitrogen content.

H. N. B.

University and Academy News

Royal Asiatic Society of Bengal

An ordinary monthly meeting of the Royal Asiatic Society of Bengal was held on Monday, the 3rd August, 1936, at 5-30 p.m.

The following candidates were balloted for as ordinary members:—

(1) *Mandhata, H. C.*, M.A. (Hist. Allahabad), Member, Pelman Institute, Teacher, formerly History Lecturer, Agra College.

(2) *Gangooly, Phanindra Lal*, M.A., Lecturer in Mathematics, Calcutta University.

(3) *Sarkar, Bijali Behari*, M.SC. (Cal.), D.SC. (Edin.), F.R.S.E., Lecturer in Physiology, Calcutta University.

The following papers were read:

1. COL. I. FROILANO DE MELLO—*Further Contributions to the Study of the Blood Parasites of the Indian Birds, together with a List of the Hemoparasites hitherto recorded.*

In this paper the author gives a complete list of the Hemoparasites recorded from Indian birds and discusses their classification and relationships. In addition, he describes a number of new species of Hæmoprotieds which he has studied in detail from Nova Goa and other places.

2. A. BANERJI-SASTRI—*The Nagas in the 3rd and 4th Centuries A.D.*

According to V. A. Smith the history of India in the 3rd century A.D. is wrapped in obscurity at present impenetrable. Mr. K. P. Jayaswal challenges this view and endeavours to prove that there was a mighty Bharasiva Naga empire from c. 31 B.C. to 284 A.D. that merged in the Vakataka empire (c. 284 A.D. to 348 A.D.). Mr. Jayaswal's reconstruction is based on two lines of a single inscription. After an examination of the evidences the writer concludes "As such a Bharasiva Naga empire must remain, pending further corroboration, a figment of the imagination". A large number of independent States flourished in Northern India side by side in the 3rd and the 4th centuries A.D. The writer also criticizes the views of Mr. Jayaswal relating to the Nagas of Vidisa and in conclusion discusses the chronology of the other contemporaneous Naga dynasties including one founded by Nava.

3. SASANKA SEKHAR SARKAR—*The Social Institutions of the Malpaharias.*

The Mâlpâhâriâs are an aboriginal tribe occupying the southern portion of the Rajmahal hills in the Santal Parganas who have adopted Hinduism and most of whom speak a Bengali dialect. The Mâlpâhâriâs of the Dumka sub-division are divided into eleven social groups or septs. Marriage tie is very loose among them. The writer attributes this to excessive alcoholism. The Mâlpâhâriâs at present use Bengali terms of kinship of which a list is given. He also describes the name-giving, marriage, and funeral rites of the tribe.

4. SAYYID WAJAHAT HUSAIN—*Âzâd Bilgrâmî.*

In this paper the author deals with an exhaustive life-history, and the contributions to Islamic literature of as-Sayyid Ghulâm 'Alî Âzâd bin as-Sayyid Nûh al-Husainî al-Wâsitî, otherwise known in the literary world as Âzâd Bilgrâmî.

Âzâd's early life and nativity. Scholastic career under Mawlânâ 'Abd al-Jalîl and Sayyid al-'Ârifîn Mîr Sayyid Lutfallâh. Itinerary in Northern Indian and Southern India. Acquaintance with Nawwab Âsaf Jâh of Deccan, and subsequent enlistment as a soldier in his army. Pilgrimage to Mecca. Death.

The author gives a detailed list of the works of Âzâd and marks him out as an erudite scholar and linguist with mastery in Arabic, Persian, Sanskrit, Urdu, and Hindî, well worth the appellation *Hassân al-Hind*. He also points out that the literary activities of Âzâd were not confined to linguistics alone, but extended to a wide field including literature, history, poetry, biography, and the Hadîth, placing him among the foremost writers of his age.

The following exhibit was shown and commented upon:

1. J. N. MUKHERJEE—*A brass Utensil pierced by Hailstone on 8th March, 1936.*

On the 24th Falgun, 1342 B.S. (8th March, 1936), there was a gust of wind accompanied with slight rain which lasted about 10 minutes in the vicinity of Mondalgram, P. S. Satgachia, Dt. Burdwan. It took place at about 7-30 p.m. Next day at 6-30 p.m. there was a severe hailstorm (Nor'wester) in the locality; the unusual feature was the large size of the stones and the velocity with which they came down. Mr. Rabindranath Bhattacharyya, of the above village, who was coming from a neighbouring village, was caught in the storm and was rendered unconscious. On regaining consciousness he attempted to reach the village but swooned again. He was later rescued in time by some men. Gour Bagdi, of village Koshigram, P. O. Nashigram, P. S. Bhatar, Dt. Burdwan, and another person are reported to have died near the same spot. The police, it is reported, removed the bodies. Mr. Bhattacharyya states that the stones were about a pound in weight. He tried to protect himself with his umbrella but he fell down and felt as if he had been struck by a log of wood. He was attended to by a medical man of the village, Dr. Anil Mukherjee. He was in a state of stupor till 2 a.m. and had 102° temperature. The fever persisted for eight days and he was confined to bed for twelve days. It was reported that brass utensils lying on the shaded verandah of houses in the village were pierced by the hailstones leaving holes as if they were struck by bullets. One of these brass utensils is exhibited. Raneegunge tile roofs have also been broken through, stones passing into the interior of the house. Palm trees have been denuded of their leaves and barks torn off on the side on which the stones struck. As often happens in such storms corrugated iron roofs of a house were bodily removed. Some of these corrugated iron sheets have been flattened by the impact.

The National Academy of Sciences, India

The ordinary monthly meeting of the National Academy of Sciences, India, was held in the Physics Lecture Theatre, Muir College Buildings, Allahabad, on the 29th of July, 1936 at 4 p. m. Prof. N. R. Dhar, President of the National Academy, was in the chair.

The National Academy of Sciences, India, congratulated its Foreign Secretary Prof. B. Sahni, D.SC., SC.D., F.R.S., F.G.S., on his being elected a Fellow of the Royal Society of London.

The National Academy of Sciences, India, expressed its great sorrow at the sad and untimely demise of Profs. K. K. Mathur and C. A. King of the Hindu University, Benares, both of them being its founder Fellows, and conveyed a message of sympathy to the bereaved families.

It was decided to award the Education Minister's Gold Medal in Physics this year.

The following papers were read and discussed:—

1. U. K. Shukla, Lucknow: Differentiation of a definite integral with respect to a Parameter in certain cases when Leibnitz's rule is not applicable.
2. Bholanath Singh & P. B. Mathur, Benares: Apparatus for the measurement of respiratory quotient in Plants.
3. A. N. Puri, Delhi: An Anomaly in the Elastic behaviour of Indian Rubber.
4. A. C. Roy, Muktesar: The Diazo-compounds of Morphine.
5. A. C. Chatterji, Lucknow: A Note on the influence of lyophilic colloids on the wettability of Naphthaline.
6. A. C. Chatterji, Lucknow: The numerical value of Traube's Factor from wettability data.
7. M. P. Gupta and Jagraj Bihari Lal, Allahabad: Chemical Examination of the seeds of Physalis Peruviana of Cape Goose Berry.
8. R. K. Chatterji and S. Dutt, Allahabad: Chemical Examination of oils from the seeds of (a) Crotolaria Medicagenea (b) Cassia Occidentalis.
9. L. D. Tewari and S. Dutt, Allahabad: Dyes derived from 3: 4: 3′: 4′—tetraamidodiphenyl.
10. B. B. Biswas and S. Dutt, Allahabad: Constitution of fluoranthrenequinone and its derivatives.

The following were elected members of the National Academy of Sciences, India:—

1. Mr. A. T. Dharam Dass, Allahabad.
2. Mr. G. P. Pendse, M.Sc., Gwalior.

Calcutta Mathematical Society

An ordinary meeting of the Calcutta Mathematical Society was held in the Society's room, on Sunday, the 16th August, 1936, at 5 p.m.

(1) A portrait of late Prof. Ganesh Prasad, was unveiled by the President of the Society.

(2). The following papers were read:—

(*a*) N. N. Ghosh—On a class of determinants having geometrical applications.

(*b*) A. C. Chowdhury—On Reducible Hyperelliptic Integrals.

(*c*) C. N. Srinivasienger—Lines of striction on the quadric and on some other scrolls.

(*d*) S. Ghosh—Plain Strain in an infinite plate with an elliptic hole.

(*e*) M. De Duffahel (Stamboul)—On a class of Integral Equations.

(*f*) A. Möessner (Nürnberg)—Simultane Identitaten.

Indian Chemical Society

J. M. Das Gupta Medal

Applications are invited for the above Gold Medal for 1936 from Research Chemists of any age. The award will be made on unpublished researches and on independent papers published in the *Journal* of the Indian Chemical Society by the candidates during the years 1935 and 1936. Application together with *four copies of each reprints or typewritten papers* should reach the Secretary not later than 30th September 1936. Relevant rules guiding the award are given below for information.

Rules

1. The medal will be awarded every alternate year.
2. The date of award will be decided by the Council.
3. The subject of investigation shall relate to any branch of chemistry.
4. The medal shall be awarded to the candidate adjudged to be the best.
5. Only unpublished researches or those published in the *Journal* of the Indian Chemical Society during the period shall be taken into consideration.
6. The Council may from time to time announce any suitable subject for the purpose of this award.
7. The Society shall have the right to publish in its *Journal*, the whole, part or a modified form of thesis for which the medal is awarded.
8. The medal shall not be awarded more than once to the same candidate.
9. No paper on the presentation of which any other prize or degree other than M.A., or M.SC., has been obtained, will be accepted.
10. The merits of the papers shall be judged either by the Council of the Society or by the Board of Examiners, appointed by it, whose decision shall be considered final.
11. If in any year no prize is awarded by reason of no candidate having shown sufficient merit to entitle him to the prize or for any other causes, the income of that year may be utilized in awarding a second prize in the next or in any subsequent year.

Botanical Society of Bengal

The sixth ordinary general meeting of the above Society was held on the 24th August, 1936 at 5-30 P.M. in the Botanical Laboratory, C. U.

The following paper was read:

Dr. H. K. Nandy—Chromosome morphology, secondary association and the origin of the cultivated rice.

University of Allahabad

At a meeting of the Executive Council of the University held on August 8, last, the following appointments were made for the Law Department:

Two readers—Mr. K. K. Bhattacharya, LL.M. (London), of Calcutta, and Mr. K. R. R. Sastry, M.L., advocate of Madras High Court.

One whole-time lecturer—Mr. Lalla Ram Tewari, B.A., LL.B., a lawyer of Partabgarh.

Two part-time teachers—The Hon. Mr. P. N. Sapru, Bar-at-Law, Allahabad, and Mr. Mukhtar Ahmad, advocate, Allahabad.

Mr. S. K. Rudra, M.A. (*Cantab.*), Senior Reader in the Department of Economics, was appointed 'Professor' of the Department *vice* Professor C. D. Thompson resigned.

Book Review

Annual Bibliography of Indian Archaeology for the Year 1934. *Kern Institute, Leyden. 1936. Pp. X+166 and plates.*

The valuable Annual of the Kern Institute, of which the ninth volume is now before us, has deservingly earned unstinted praise from all quarters and has won a unique and indispensable place in the world of Indian archaeological research. The present volume opens with Dr. C. L. Fabri's account of the work done by the Archaeological Survey of India during 1933-34. At Mohenjo-daro a small mound in the *Dk* area, belonging to the Late Period, was excavated. On the basis of a seal with the representation of a bi-cephalic animal, Dr. Fabri thinks that the so-called unicorn is nothing but an imaginary animal. Mr. Vats' excavations in the 'Workmen's Quarters' at Harappa have brought to light a burnt clay sealing, bearing the effigy of a horned man in a dancing pose. Dr. Fabri calls it a 'Devil Dancer.' We should note, however, that the horns often indicate divinity in ancient art, and that later Indian art and mythology make us familiar with the conception of a dancing god *(Nataraja)*. But a definite judgment must be deferred till a photograph of the sealing is available to us.

The work done on this site of the ancient Kurukshetra reveals the existence of two strata, one belonging to the thirteenth and fourteenth centuries and the other, the lower one, to the third and fourth centuries. The importance of Kurukshetra in the political and cultural history of India is immense and we may expect that deep digging will expose some earlier strata. Dr. Fabri further mentions the excavations done at Paharpur, at Nalanda, where some cells show clearly the shape of well-built true arches, and at Bijai Mandal in Delhi, the remains of which are identified with the Hall of Thousand Pillars mentioned by some Muhammadan historians. The discovery of dolmens at Pipalgaon (District Bhandara, C. P.) and at Chettipalaiyam (District Coimbatore, Madras) is very interesting.

In the Numismatic Notes, Sir Richard Burns, examining the case of a Mauryan coinage, rejects the proposed readings of Mr. K. P. Jayaswal and complains of the unhealthy practice of drawing conclusions 'by picking out names from different series of ancient coins, a method which neglects the evidence of find-spots and epigraphy.' Among the acquisitions of the Mathura Museum, mention may be made of a three-headed image of Vishnu (?) with a lion's head on the proper right and a boar's head on the proper left. At Maski, famous for its edicts of Asoka, the Archaeological Department of the Nizam's Government did some excavation, as a result of which it is suspected that the place was the abode of the neolithic man for a considerable period. At Warangal a colossal but unfinished temple with excellent carving has been found.

In Ceylon epigraphical discoveries by the local Archaeological Department prove *inter alia* that the royal title *gamani* goes back to at least the third century B. C. The clearing of the debris of a *stupa* at Mihintale shows that the *stupa* was a monument of great architectural importance.

In the section on Indonesia, Dr. Robert, Freiherr von Heine-Geldern contributes a remarkable article on the Pre-historic Culture in Indonesia. As, owing to the presence of Austric-speaking peoples all over India, the question of Indonesian pre-historics is of great importance to Indian archaeology as well, a summary of this rather long article is given elsewhere.

It is hardly necessary to dilate on the merits of the bibliographical portion of the book, with its thorough classification, richness of details, etc. We, however, feel constrained to say that it is rather poor so far as articles published in Indian vernaculars are concerned. Only a very limited number of Bengali and Hindi periodicals have been utilized, those in other vernaculars being altogether neglected. We draw the attention of the editorial board to this fact with the hope that efforts will be made to rectify this shortcoming.

We note with great satisfaction that some of the progressive Indian States have been generously giving financial assistance to the Kern Institute. In the Foreward Professor Vogel also records the indebtedness of the Institute to Dr. B. C. Law, the renowned scholar of Calcutta.

A. Ghosh.

Modern Radio Servicing—*By A. A. Ghirardi, published by Radio and Technical Publishing Co., 45, Astor Place, 1935. Price $4.00.*

The present book is an entirely rewritten and an enlarged edition of the author's small book *Radio Servicing Course*. It contains 1,300 pages and 706 illustrations and is one of the best books on the subject. The book is divided into 4 parts.

Part 1 is spread over 426 pages and contains a detailed study of various types of testing instruments. Complete details are given for the construction of ohmmeters, set analysers, capacity meters, output meters, test oscillators and other useful apparatus. In addition to this there is a fairly good description with diagrams of several commercial measuring instruments put in the market by American firms.

Part 2 consists of about 450 pages, and deals with the practical servicing of radio receivers. The automatic volume control, silent tuning systems, and various methods used as resonance indicators are described in detail. Practical hints are given for locating faults in radio receivers. A fairly exhaustive chapter consisting of about hundred pages deals with aligning of superheterodyne receivers. The use of cathode ray oscillographs for receiver adjustments is also dealt with. The oscillograph and its associated equipment is fairly well described. A chapter is also devoted to the repair of individual radio components.

Part 3 deals with specialized servicing problems. There are chapters on Auto Radio, and Marine Radio receivers, servicing of all wave receivers, electrical interference, high fidelity receiver problems. In big industrial cities considerable trouble is experienced from man made static due the considerable use of various electrical appliances, such as lifts, refrigerators, motor pumps, trams, etc., etc. The chapter on electrical interference explains how such trouble arises and what steps can be taken to avoid the trouble. Various types of interference eliminating aerials are also described. This chapter should prove very interesting to both the service man as well as to the listeners.

Part 4 contains charts of data of various types of glass as well as metal American tubes.

The book as a whole is very interesting and should prove very useful to all interested in Radio.

G. R. T.

Radio Field Service Data—*By A. A. Ghirardi and B. M. Freed, published by Radio Technical Publishing Co. $1.50.*

This book is a supplement to the *Modern Radio-Servicing*. It contains a large amount of information about American receivers such as intermediate frequencies, radio tube characteristics, and tube socket charts, R. M. A. color code etc., etc. There are tables for copper wire, resistance wires, frequency wave length and L C conversion. The book is a handy volume and should prove very useful for servicing of American receivers.

G. R. T.

Race, Sex and Environment—*By J. R. de la H. Marett, Hutchinson, London 1936, price 21s. net.*

The author of this book is the son of the famous Rector of the Exeter College whose retirement has just taken place. He was originally a student of animal husbandry with a good working knowledge of genetics, soil science and other associated subjects. Being early influenced by Sir John Orr's *Minerals in Pastures*, and Crew and Goldschmidt's researches in Inter-sexuality he thought of applying similar principles to explain the course of human evolution and took the diploma in Anthropology given in Oxford as a preliminary general training for his work.

That environment has played a determining part in the evolution of animal and human races has long been recognized, but exactly how this has been brought about has not been investigated. The author has attempted to find this causal nexus in Mineral Deficiency and has sought to explain the differentiation of Man into local types or races as a result of the economy of the mineral contents of the soils inhabited by him. Thus lime deficiency of humid regions encouraged femininity by reducing the mass of the skeleton (p. 20), and abundance of calcium and phosphorus in arid tract on the other hand has fostered the development of robust skeletons as in the Neanderthal Man, but the iodine shortage of these regions again favoured foetalization. Human races, in the author's opinion, are therefore due to a mixture between a hypothecated Northern or Palaeanthropic type with powerfully built body and adopted to a lime-rich arid country and a more feminine but quick developing Southern or Neanthropic type adapted to the decalcified soils of the tropical moist countries. This mineral deficiency of the soils has further been advanced as an explanation of the often observed correlations between the differences of body and character. Thus the foetalization of man—which is the result of iodine shortage "is responsible for the inhibition of intra-group pugnacity" and sexual selection determined by mineral deficiency is thus made to play an important part in the nature of Oedipus Complex.

The attempt to explain the development of man and his culture as a direct result of environmental conditions has undoubtedly much to be said in its favour and the author's suggestions in many places are thought provoking, but in going through the book one is struck by the altogether imaginative character of the work and the effects to mask the weakness of facts by wish-thinking hypotheses, for instance, arising from a common Neanthropic pygmy ancestry the Bushmen became dwarf by being "specialized to desert conditions" which however are arid and rich in lime contents and the Negro became one of the most stalwart races of the world by being "enlarged due to the better conditions of the tropical park lands" (P. 222—223)! The author is apparently unaware of these contradictions for which explanations like "unmasking of old characters" and hypothetical racial mixtures are conveniently brought to his rescue whenever he finds himself in a tight corner.

In the opinion of the reviewer, instead of attempting to explain the whole course of human evolution the author would have been better advised to study the effects of mineral shortage on a selected group of people in a particular region about which the necessary data are available, in that way he would perhaps have made a better case for his theories than by the speculations he has indulged in.

B. S. Guha.

Letters to the Editor

On the Constitution of an Acid isolated from Pineapple

In course of preparation of Vitamin C from pineapple (*Ananas sativo*, Linn.) Dr. B. C. Guha and Mr. A. R. Ghosh isolated a crystalline acid which they kindly placed at our disposal for the determination of its constitution. The crude acid, of which only four grams were available, was repeatedly crystallized from hot water when it formed pale cream-coloured plates, m.p. 120°—126° (not sharp). The acid was optically inactive and did not decolourize bromine water. It was indifferent towards ammoniacal silver nitrate solution, ferric chloride and Fehling's solution. o-Dinitro benzene in alkaline medium did not develop any violet colour when heated with the acid thus showing the absence of —CO—CHOH— group[1]. The acid did not form an oxime.

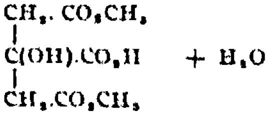
Attempts to purify the acid by distillation in high vacuum resulted in the isolation of two substances. At about 90°/ 0·05 mm. a small quantity of a crystalline substance (A), m.p. 78—80°, sublimed and at 140—45°/0·03mm. the major portion distilled over as a colourless viscous oil, practically no residue being left. This distillate did not solidify on cooling but became crystalline in contact with water. When exposed to the atmosphere it crystallized only superficially showing that water played some part in the crystallization of the distillate. Crystallized from hot water it melted at 121—23° (B). This was a neutral substance and its aqueous solution could be kept unchanged for days. It was believed to be a lactone.

The product (A) was also found to be neutral. To find out whether the substance (A) accompanies the original acid as an impurity or not, the crystallized acid was repeatedly washed with cold ether, in which the substance (A) is easily soluble but in which the acid is sparingly soluble. The residue, after removal of ether, was sublimed in vacuum when a crystalline colourless substance passed over at about 90°/ 0·05 mm. and melted at 80°. This was found to be identical with the substance (A) previously isolated. The acid, which had been freed from the substance (A) by ether, gave on distillation in vacuum only the lactone (B). It is therefore clear that the original acid even after several crystallizations from hot water had retained a crystalline substance, m.p. 80°, as an impurity. The pure acid melted at 125—27° (not sharp). From potentiometric titration it was found to be monobasic, the equivalent of acid being in the neighbourhood of 240. Analytical data agreed with the formula, was heated with alkali on the water-bath and the excess of alkali titrated back with acid we got a value which was three times the titration value of the acid at room temperature. This shows that on alkaline hydrolysis two —CO₂H groups are set free. We could not however isolate any of the products of hydrolysis as the quantity of substance at our disposal was not enough. The partial formula of the acid, assuming it to be a methyl ester, becomes therefore

$$C_3H_4O\begin{cases}-OH\\-CO_2H\\-CO_2CH_3\\-CO_2CH_3\end{cases}\quad\text{or}\quad C_3H_4\begin{cases}-OH\\-CO_2H\\-CO_2CH_3\\-CO{-}O-\\-OCH_3\end{cases}$$

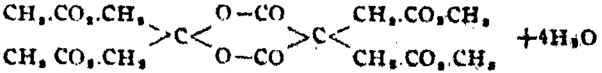
It cannot be a dimethoxydilactonic acid as this supposition demands nine oxygen atoms in the molecule.

The clue to the constitution of the acid was furnished by a methyl derivative of the acid obtained by the action of diazomethane. The resulting compound was neutral, melted at 79° and was found to be identical with the substance (A) isolated from the crude acid in small yield. This substance from analysis and other properties was definitely identified as trimethyl citrate. The acid must therefore be a dimethyl citrate and indeed agreed in properties with symmetrical dimethyl citrate. The identity was finally established by comparing our acid with a synthetic specimen of dimethyl citrate (I). The synthetic acid also passed into a stable lactone on distillation in high vacuum, the crystallized lactone being identical with our substance (B). In view of its stability, the lactone is presumably to be given the constitution (II).



$$\begin{array}{l}CH_2.CO_2CH_3\\ \vert\\ C(OH).CO_2H \quad + H_2O\\ \vert\\ CH_2.CO_2CH_3\end{array}$$

(I)



(II)

University College of Science,
Calcutta, 1. 8. 36.

P. K. Bose.
S. N. Bhattacharyya.

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[1] Bose, *Zeit. Anal., Chem.*, *87*, 110. 1932, Benzoin also responds to the test.

Preliminary Note on *Clerodin* from Clerodendron Infortunatum

Indian Bhat—C. infortunatum—is a common medicinal plant extensively used in ayurvedic practice. Two crystalline organic principles have been isolated in the pure state from the leaves by extraction in light petroleum ether.

(1) One of these is bitter and is crystallizable from organic solvents in colourless needles.

(2) The other is not bitter and is obtained from the residue left after separation of the bitter substance, in hexagonal plates.

A preliminary note on the bitter substance is given below :—

Shape—Crystalline colourless needles.

Solubility—Easily soluble in organic solvents generally. Very sparingly soluble in water; saturated aqueous solution at 30°C contained 0.06 grams in 100 c.c.

Melting point—161°C—162°C.

Specific rotation in alcholic solution— $[\alpha]_{D}^{30^\circ C.} = -37.6$

Results of Combustion Analysis

% Carbon =70.46, 70.42

% Hydrogen= 8.19, 8.27

Sulphur, Nitrogen, Phosphorus, Halogen etc. absent.

Molecular weight found by Rast Method=212, 217.

Whence, Molecular formula=$C_{13}H_{18}O_3$

Theoretical values for carbon, hydrogen and molecular weight from the above. C=70.27%

H= 8.19%

Molecular weight=222.

The anthelmintic property of the bitter principle was tested by the following physiological observations :—

Earthworms placed in aqueous solution show contraction immediately, becoming completely paralysed within 4 minutes and die within half an hour.

Tadpoles die within 15 minutes.

Tubifex, Rotifera and Vorticella become completely inactive within an hour.

Amoeba and protozoa were found to be rather resistant.

Worms obtained from the intestines and the peritoneal cavities of fish were killed by the aqueous solution of the bitter substance within 7 minutes.

No haemolytic effect was observed in normal saline.

Fuller details of the complete investigation will be published in the *Transactions* of the Bose Research Institute.

Bose Research Institute,
Calcutta, 5. 8. 36.

Hirendra Nath Banerjee.

Bromo- and Nitro-Derivatives of Ayapanin

Ayapanin is obtained from Eupatorium Ayapana, vent[1].

Dibromo-ayapanin, $C_{12}H_8Br_2O_4$, is formed by the direct action of bromine on ayapanin in the dry state or when ayapanin is held in suspension in water or in solution in organic solvents. The pure dibromo-ayapanin may be crystallized from acetone solution in radiating needles, which are *slightly* brownish in colour. and melt at 248°C—249°C. The reaction may be represented by the following equation :—

$$C_{12}H_{10}O_4+2Br_2=C_{12}H_8Br_2O_4+2HBr$$

Total quantity of bromine used up in the reaction, as also the amount of hydrobromic acid formed have been determined. The amount of bromine in dibromo-ayapanin, estimated as AgBr, gives theoretically correct figures, within limits of experimental error.

0.0176 gram Dibromo-ayapanin gave

0.0177 gram AgBr, theoretical figure being 0.0176

Molecular weight by Rast method, found =379

Molecular weight calculated, theoretical =376

Mononitro-ayapanin $C_{12}H_9O_4NO_2$, is formed when a solution of ayapanin in a very small quantity of concentrated sulphuric acid is gently warmed on a waterbath and treated with sufficient quantity of concentrated nitric acid and the mixture is left over for 24 hours. The nitro compound separates out and is purified by washing with water. The substance is slightly yellow in colour. Gently heated, the nitro compound melts to a darkish coloured liquid, giving fumes with a sweetish odour and taste recalling the smell of nitro-benzene, ultimately burning off with a smoky flame.

The amount of nitrogen was estimated and found to correspond to the mono-nitro formula.

Molecular weight by Rast method, found =259

Molecular weight calculated, theoretical =263

Other results and fuller details will be published in the *Transactions* of the Bose Research Institute.

Bose Research Institute,
Calcutta, 7. 8. 36.

K. N. Bose.
N. C. Nag.

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[1] Nag, N. C., and Bose, K. N.,—An Organic Principle in *Eupatorium Ayapana*. Vent. *Trans.* Bose Res. Inst., *8*, 195-198., 1932-33.

LETTERS TO THE EDITOR

The Racial Affinities of the Inhabitants of the Rajmahal Hills

Since the opening of the section of Anthropology in this Institute, systematic anthropometric investigations on the mundas and the Oraons were carried on by the late Dr. P. C. Basu[1], and on the inhabitants of the Rajmahal Hills by the present writer. The hill people of the Rajmahal Hills have been treated in three groups:

1. The Hill Malers, who are still in a primitive state and live on the hill tops;
2. The Plains Malers, who have come down to settle on the plains.
3. The Malpaharias[2], who are now separated from the parent stock of the Malers and have been largely exposed to Hindu influences.

From an anthropometric study of the above three groups it is seen that both in physical features as well as in culture it is difficult to separate one from the other.

The Oraons of the neighbouring Chota Nagpur Plateau speak a Dravidian tongue like the Malers and it is held on this ground and on the identity of a few other cultural traits that they are closely related[3]. From a comparative study of the physical features of the Malers and the Oraons it is found that the Oraons are taller than the Malers; in the breadth-height index of the head the Oraons being largely tapeinocephal whereas the Malers acrocephal; the nose of the Malers is more platyrrhine than the Oraons; the face of the Oraons is mesoprosopic whereas that of the Malers in euryprosopic with a large percentage of disharmonic faces, and the epicanthic fold of the eye is not uncommon among them. The latter two characters are rare among the Oraons. The Malers possess a darker skin colour than the Oraons and there is considerable difference in the eye colour as well.

The dissimilarity in the cultures of the two groups is also very great. The Oraons have a long list of exogamous clans whereas the Malers have none. If the Malers and the Oraons had separated from one parent stock, one wonders how such an important social system happened to be forgotten among the Malers only. Traces of dual organization[4] are present among the Malers, whereas they are not found among the Oraons. It is true, of course, that a large number of social institutions are falling into disuse among the Malers but traces of the old customs are yet discernible in their social system.

In view of these considerations the present writer is inclined to think that the Malers and the Oraons are two upwards thrusts of two different Dravidian-speaking peoples from the south and they never came into actual contact with each other.

Details of the anthropometric observations and the Maler-Oraon affinities will be published in the *Transactions* of this Institute.

S. S. Sarkar.

Bose Research Institute,
Calcutta, 12. 8. 36.

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1. Basu, P. C.—*Transactions of the Bose Research Institute*, Vols. VIII & IX.
2. Sarkar, S. S.—The Origin of the Malpaharias, *Indian Historical Quarterly*, *9*, No. 4, p. 886, 1933.
3. Roy, S. C—*The Oraons, Ranchi*, p 10, 1915.
4. Haddon, A. C.—Introduction to *The Oraons* by S. C. Roy, Ranchi, p. xiii, 1915.

Obituary

Dr. Panchanan Mitra

Dr. Panchanan Mitra, Head of the Department of Anthropology, Calcutta University, died suddenly on July 25, of meningitis at his Calcutta residence at an early age of forty-five. In his death Indian anthropology in general and prehistory and cultural anthropology in particular have sustained a severe and almost irreparable loss.

He was born on the 25th May, 1892, in the Mitra family of Beliaghata, a suburb of Calcutta, well-known in those days for their catholicity of outlook, generosity and wide learning. He was the eldest son of Kumar Udayendralal Mitra and the grandson of Raja Rajendralal Mitra, a *clarum et venerabile nomen* in the domain of Indology. To be born and brought up in this atmosphere of Indological and classical learning was itself a sufficient stimulus for the expansion of his mental outlook. From his boyhood he had a passion for knowledge. It is no wonder then that from his boyhood right up to the final University Examination his career was be uniformly brilliant. He graduated in 1912 from the Ripon College, with Honours in English, being placed first in the First Division. After passing the M.A. Examination in 1914 in English with distinction he worked in the Bangabasi College as a Professor of English Literature for a period of 4 years (1915—1919). Indian anthropology was then in a very infantile stage. And though it must have been a very uphill work to be familiar with prehistory, an untrodden field in Indian anthropology then as it is today, he soon submitted his thesis, entitled *Prehistoric Arts and Crafts,* for the much coveted Premchand Roychand studentship. His thesis was accepted, and was later published by the University in a book form entitled *Prehistoric India* (1928) which, in the opinion of Boule, "ought to find a place in the library of every palaeoanthropologist." A few more lines from Boule's review merit quotation.

Dr. Panchanan Mitra (1892—1936)

"Prehistorians of the West will find something to learn from Mr. Mitra's work; it will widen their range of vision beyond the familiar horizon; it will compel them to consider aright the new problems, it will help them to come to a wider and, at the same time, a more precise understanding of questions relating to the origins and development of humanity.

He was absorbed into the Post-Graduate Department of the University in 1919 first as a lecturer in Ancient Indian History and Culture, and when the Anthropology Department was started in 1920 his services were transferred to it, of which subsequently he became the Head.

The year 1928 brought a new phase in his career. The chance visit of Dr. E. C. Craighill Handy of the Bishop Museum of Honolulu to Calcutta during the Indian Science Congress held in the early part of the year gave him an opportunity of visiting Polynesia and America. Dr. Handy's object of visit to India was to trace the origin of some of the Polynesian cultural traits that, he believed, ought to be found in India, the supposed centre of dispersal of the Proto-Polynesians. He found Dr. Mitra to be the most capable ethnologist to aid him in his search for Indian elements in Polynesian culture. The spirit of 'Greater India' brought him to this new field of work. Early in 1929, at the invitation of Dr. Gregory, the director of the Bishop Museum of Honolulu, he sailed for Honolulu and visited on behalf of the said museum the different parts of Polynesia which gave him an ample opportunity to study *in situ* the Polynesian cultures. The results of his studies have been embodied in his monograph *Indian Elements in Polynesian Culture* to be published as a memoir of the Museum. After the completion of his works in Polynesia, he joined the Yale University to which the Bishop Museum is affiliated, and worked under Prof. Clark Wissler on the American methodology in the interpretation of 'Man & Culture.' He soon got the degree of Doctor of Philosophy on production of a thesis, entitled *A History of American Anthropology,* published in a book form by the Calcutta University in 1933.

In him there was a curious blending of research organizing power and teaching capacities. Before he took over the charge of the Head of the Department in 1932, organized research work in the department was in sad plight. Since his return home from America in 1930, he put all his experiences gathered in course of his tour in America and field work in South France into action. Like Haddon in Cambridge, he organized "a teamwork both in the laboratory and in the field." The best result of this organization of field work, through the generous financial help from Prof. Clark Wissler, was among the hitherto little-known tribes in Manipur. The investigation was undertaken by Mr. J. K. Bose, one of his best pupils, under the joint direction of him and Prof. Clark Wissler. It is to be deeply regretted that he did not live longer to see the publication of monographs on "Aimol Kukis" and "Manings," the products of the investigation. It was only in October last that he co-operated with Dr. Helmuth de Terra, leader of the Yale North Indian Expedition in Kashmir, and sent one of his research scholars, Mr. D. Sen, to take part in the Expedition.

He was connected with many learned societies of both Europe and America, e.g., American Anthropological Association, American School of Prehistoric Research, the Royal Anthropological Institute of Great Britain and Ireland. He was invited by Prof. R. Biasutti of Florence to contribute to the now-famous Italian Encyclopedia articles relating to Indian Ethnology. He was President of the Anthropology section in the Indian Science Congress held at Patna in 1933, President of the Anthropo-Genetics Section of the All-India Population Conference held at Lucknow early this year, and Editor of the Anthropology section of the newly started *Bangiya Mahakosh,* an encylopedia written in Bengali. Unlike many Indian professors, he used to take keen interest in the social works. He was for sometimes a member of the Calcutta Corporation and also took active part in the relief works during the North Bengal flood.

He won the admiration of his colleagues, friends, and students for his *bonhomie,* and righteousness. His view of life was always marked by a robust optimism, and the present writer who was intimately connected to him for many years, hardly remembers an occasion when he was in utter depression. He was ever ready to help anybody who came to him for it. His death has removed from us not only a scholar, but a fine personality.

J. K. G.

Lt.-Col. R. Knowles

We regret to have to announce the death of Lt.-Col. R. Knowles, C.I.E., M.R.C.P., L.R.C.P., I.M.S., acting director of the School of Tropical Medicine, Calcutta on August 3 last at the early age of 53, of heart failure following gastric hæmorrhage.

SCIENCE AND CULTURE

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The Problem of Nutrition in India

In tune with a world-wide awakening of public conscience to poverty and malnutrition as a scientific and social question, there seems also to be a similar awakening in this country, where this problem is undoubtedly one of the acutest in the whole world. The unprecedented economic crisis of recent years helped to concentrate attention on this matter. On the one hand, it brought out in bold relief the tragic feature of modern social economy that in plethoric plenty people perish, that thousands of bushels of wheat are allowed to be burnt, while millions go hungry; and on the other, it was painfully realized that the prosperity of the industrial community itself was intimately bound up with the purchasing power of the masses, that even profiteers should take care in their own interest that the larger section of the people is not sucked dry. The speeches of Mr. Stanley Bruce and of Lord de la Waar at the League of Nations Assembly, to which reference has often been made, regarding the problem of poverty and malnutrition throughout the world, are, therefore, to be taken in the context of the crisis, which took the complacent capitalist world by storm and proved that all was not well.

India fits in this picture remarkably well. During the crisis her trade also contracted phenomenally. The proverbial poverty of her people became more appalling. Owing to the further lowering of the already low purchasing power of the Indian consumer, the Indian market for foreign (including British) manufactured goods also suffered a serious set-back. In India, again, the state of poverty is bound up not merely with malnutrition but also with starvation, semi-starvation, and consequent ill-health and all-round inefficiency. This state of affairs is obviously good for nobody concerned.

The problem of adequate food, adequate both qualitatively and quantitatively, for India's teeming millions, is one which calls for paramount attention from the administrative authorities, the constituted public bodies, the scientists, and the public. Food and nutrition constitute obviously the bed-rock of life, health, and efficiency. Practically all civilized Governments, barring that of India, have assumed the responsibility of feeding the people in their charge. They have fed their unemployed. Now they are turning their attention not merely to feeding them but feeding them well. They are determined to raise their nations to the A1 standard. Things, however, have moved in this country remarkably slowly, as usual.

Credit is, therefore, due to His Excellency Lord Linlithgow for giving an energetic lead in the right direction in this country during the last few months. Lord Linlithgow was intimately associated with and guided the activities of the British Medical Research Council and of the Empire Marketing Board in England. The malnutrition of large sections of the working classes in Britain from the standpoint of optimum nutritional standards, to which pointed attention was drawn by Sir John Orr, has stimulated activity in that country and Lord Linlithgow has also been associated with it. It is re-assuring, indeed, to see him beginning to give effect to some of the recommendations of the Royal Commission on Agriculture, over which he had presided, soon after the assumption of office. The decision to establish institutions for animal nutrition and poultry research is an instance in point.

Co-ordination of Nutritional Work and a National Food Policy

The question of human nutrition is intimately associated with those of agriculture, animal husbandry, and public health. This is clear to all. Nevertheless, it is curious that practically in no country of the world has there been up till now any organized State policy for co-ordinating work and information in these different departments and to effectively apply the results to the improvement of the standard of health and nutrition of the people. Agricultural policy, for instance, in all countries, including India, has been almost solely determined by considerations of agricultural economics, production, marketing and so forth and hardly at all by considerations of the nutritive values of the food-crops, though it is obvious that these food-crops are ultimately to be eaten by both the producer and the purchaser. Indeed, the question of food values has hardly even come under the purview of the Imperial Council of Agricultural Research, which has been so far sponsoring schemes of agricultural research, related to production, fertility, genetics, disease-resistance, economic values, etc. Work on animal husbandry and dairying has also been going on in this country, though not on a scale warranted by India's large possession of live-stock, but this work has hardly been related either to the agricultural or the public health policy. Some of the researches conducted under the auspices of the Indian Research Fund Association have been related to the nutritional problem, especially those carried out by Sir Robert McCarrison, who first pointed out the nutritional deficiencies of the dietaries commonly consumed in Bengal and in South India. Unfortunately, there has not been up till now any common central board of committee for co-ordinating all this work on agriculture, animal husbandry, and human nutrition. Such a board is necessary to suggest, guide, and develop a comprehensive course of research to be carried out regionally in all aspects of nutrition without omission or overlapping, and what is still more important, it could help to form and mould a central State policy with regard to food and nutrition, to be implemented by the provincial Governments.

The Indian Nutrition Committee

The creation of such a central board or committee has been urged several times by Dr. B. C. Guha during the last four years and particularly at the Calcutta session of the Indian Science Congress in January, 1935. It would seem that a committee for this purpose, in order to be authoritative and effective, must include representative men connected with nutritional research, agriculture, public health, economics, and statistics. It would, as stated before, co-ordinate and guide nutritional researches in all aspects and make all of them flow into one big stream with the clear-cut object of promoting a better standard of nutrition and health among the people. It would act as a pooling centre and clearing house of all nutritional information and actively take up the work of disseminating the necessary knowledge among the people. It should function as a central board of reference for the Government, the public bodies, and the public. It should, further, constitute the link between the nutritional work in this country and that carried out abroad. Such a comprehensive programme of work requires that this committee should not be subsidiary to any particular research organization, medical or agricultural, but, rather, all organizations and individuals interested in the problem of nutrition should feed it with information and unite under its auspices for exchange of notes. Above all, it is essential that in this important constructive work, all institutions, whether working under the auspices of the Government or universities or privately, should pull their weight together; there should be no distinction between "official" and "unofficial" institutions, between "official" and "unofficial" workers. We regret to state, in passing, that in inaugurating the Nutrition Advisory Board recently, H. E. the Viceroy referred to the work at Government institutes but failed to mention the important work carried out at the Indian Institute for Medical Research at Calcutta or at the University of Dacca. Yet, it is noteworthy that since the pioneering work of Sir Robert McCarrison on problems of Indian nutrition, the first systematic survey of the nutritive values of Indian foodstuffs and dietaries was taken up at the Indian Institute for Medical Research, which owed its origin purely to public initiative. Many of their researches have been published and cannot possibly be ignored. Perhaps, His Excellency was not made aware of researches carried out outside Government institutions. This gulf between Government and non-Government organizations, which, in point of fact, unhappily exists in this country, must be bridged in a constructive endeavour of the present type, whose success, indeed, depends on the obliteration of such artificial differences. The central nutrition committee should thus contain representatives of all active institutions, interested in this question, official or unofficial. It is to be hoped that the newly formed Nutrition Advisory Board, attached to the Indian Research Fund Association, will actively cooperate with this central comprehensive committee in furtherance of the common object. This committee should assist and be assisted by the Government departments concerned, so that a central State policy, and, if necessary, a central State department for nutrition and health may be brought into being. With the object of developing such an authoritative central organization, the Indian Nutrition Committee was set up at the Indian Science Congress held at Indore in January 1936 at Dr. B. C. Guha's suggestion. It contained representative men drawn from various departments and from various parts of India, all interested in this question. It is to be hoped that this committee will grow steadily into a more powerful and representative organization to which all interested individuals and organizations as also the subsequently formed Nutrition Advisory Board of the I.R.F.A. should lend active assistance for the promotion of the general weal. The I.R.F.A., we might incidentally urge, should extend its financial patronage to nutritional researches wherever they are carried out, whether in Government or non-Government institutions.

Human and Animal Nutrition

Finally, we must congratulate the Government on their increasing attention to this urgent question and on their decision to establish institutions for animal nutrition and poultry research at Izatnagar. We do hope that this will be followed up as soon as possible by the establishment of an institute of human nutrition, which proposal is already afoot and was put forward long ago by the Royal Commission on Agriculture. Both nutritional work and the dissemination of nutritional knowledge require to be speeded up. Model dietaries have to be constructed, which are within the means of our impoverished masses and agricultural practice should, to a great extent, follow nutritional requirements. Meanwhile, the production of milk (good quality milk from well-fed cows and buffaloes) needs to be stimulated. Milk is the one food which can, to a considerable extent, correct the ordinary deficiencies of Indian dietaries. And if both Government and the people pull their weight together, we can reasonably hope for better times.

Rothamsted Experimental Station

S. P. Raychaudhuri
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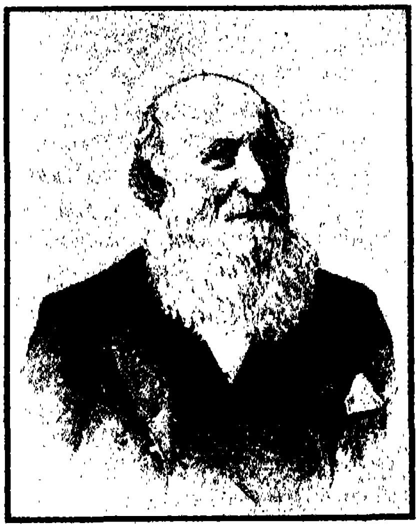
General Account with a Short Life Sketch of the Founder

ROTHAMSTED Experimental Station, the oldest Agricultural Institution in the world, is situated in the county of Hertfordshire in England, and is nearly twenty-five miles north of London.

Sir J. B. Lawes. 1814—1900

First Laboratory. 1843—1855

The founder of the Institution, Sir John Bennet Lawes, a Hertfordshire landowner, was born on December 28th, 1814, in the Manor family of Rothamsted and was educated at Eton and Oxford. In 1834 he entered into the possession of his hereditary property at Rothamsted. From this year he began his brilliant experimental works in Agricultural science and continued it throughout his long industrious life with far-reaching results which will make his name immortal through centuries to come. In recognition of his eminent service to agriculture, Sir John Lawes was the recipient of many honours and distinctions in his life-time. He was elected a Fellow of the Royal Society in 1854 and was created a baronet in 1882. He died at Rothamsted on August 31st, 1900, in his 86th year.



Sir J. H. Gilbert. 1817—1901

Although, however, much useful work had been done in earlier days, the foundation of the station is usually assigned to the year 1843. From that year, the laboratory experiments had begun on a systematic basis and from June 1st that year Mr. Lawes obtained the service of a young chemist, Dr. Joseph Henry Gilbert (later Sir J. Henry Gilbert) for managing the scientific superintendence of the experiments at Rothamsted. Since that time these two illustrious persons have worked together till the death of Sir John Lawes in 1900, a period of fifty-seven years.

Lawes Testimonial Laboratory. 1855—1914

Up to the year 1855 the laboratory experiments were carried out in the barn laboratory. The accommodation there was soon found to be too inadequate, and very appropriately the money which had been raised by many prominent agriculturists to present a testimonial to Sir J. B. Lawes in recognition of his services to agriculture was utilized in the construction of a laboratory. The Presentation Laboratory was formally opened on the 19th of July, 1855. Since its foundation the Rothamsted Experimental Station had been financed mainly by Sir. J. B. Lawes. For the continuance of the investigations after his death, he set apart a sum of £100, 000, besides the laboratory and certain areas of land, to a board of trustees in 1889.

The fiftieth anniversary of the Rothamsted Experimental Station was celebrated in 1893 and amongst the testimonials given to Sir J. B. Lawes and Dr. Gilbert on this occasion there were: (1) a granite memorial with a suitable inscription erected in front of the laboratory building, and (2) illuminated addresses of congratulation to Sir J. B. Lawes and Dr. Gilbert signed by H. R. H. the Prince of Wales on behalf of the subscribers. Besides, there were many addresses from scientific and agricultural institutions from home and abroad. A fortnight after the Jubilee celebration at Rothamsted, Dr. Gilbert received the honour of Knighthood.

Joseph Henry Gilbert was born on August 1st, 1817, and received his education at Glasgow and at the University College, London. He took special interest in chemistry. He took the degree of Doctor of Philosophy by working in the laboratory of Prof. Liebig at Giessen, Germany. Sir J. H. Gilbert was the recipient of many honours and distinctions in his life-time. He was elected a Fellow of the Royal Society in 1860, and in 1867 the council of the Society awarded to him, in conjunction with Sir John Bennet Lawes, one of the Royal Medals. Sir J. H. Gilbert was elected a member of the Chemical Society in 1841, the year of its formation, and President of the Society in 1882-83. He died on December 23, 1901, in his 85th year.

From 1902 to 1912 Sir A. D. Hall was the Director of the Rothamsted Experimental Station and was succeeded by Sir E. John Russell, who has been the director of the station from 1912 up to the present time.

The present laboratory was erected in 1914 on the site of the older building built in 1855. A separate, new building was built up in 1924, which accommodates departments of Plant Pathology and Entomology. Besides this, another building known as the Red Gables was taken over in 1929, which accommodates also the Imperial Bureau of Soil Science.

The scope, at present, of laboratory investigations extends over different branches of plant nutrition and plant disease. The main departments are Chemistry, Physics, Botany, Bacteriology, Fermentation, Microbiology, Insecticides, Entomology, Plant Pathology, Statistics, and Field Experiments. There is also a very complete agricultural library of 23, 000 volumes.

Laboratories for Soil and Plant Nutrition, Erected 1914—1916.

The area of land under the Rothamsted Committee exceeds 500 acres, of which 55½ acres are permanently under experiments and include classical fields like Broadbalk, Hoosfield, Barnfield, and Park Grass, which have been producing almost continuously, year after year, wheat, barley, mangold, and grass respectively. Besides, there are about 224 acres of land, which are occasionally under modern experiments, producing various crops or grass. Experiments on the management of cattle, sheep, and pigs form an important part of the work of the farm at Rothamsted.

A Brief Account of Some Classical Experiments at Rothamsted

In the early days of the nineteenth century Priestly and de Saussure had shown that by the influence of sun-light green plants decompose the carbonic acid of the atmosphere, setting free the oxygen and retaining the carbon which makes up the bulk of the dry matter of plants. This was later on clearly established by the brilliant researches of Boussingault in 1834 and of Liebig in 1840, who showed that the plants derived their carbon mainly from the atmosphere and that the humus of the soil contributed practically nothing to it. The source of the nitrogen of vegetation had, however, remained unsettled. De Saussure and Boussingault held the view that the plants derived their nitrogen only from the soil and the manure. Liebig, in his famous report to the British Association on "Organic Chemistry in its applications to Agriculture and Physiology" published in 1840 and again in 1843, held similar views, although he thought that the nitrogen taken up by the plants was derived mainly from the ammonia which was brought down from the atmosphere by the rain, and also that some leafy plants could assimilate and fix free atmospheric nitrogen. He thus came to the conclusion that a supply of combined nitrogen was unnecessary or at least of secondary importance. Liebig also held the view that ash analysis was a sufficient guide to the fertilizer requirements of the crops. This was more or less the position of the theory of plant nutrition when Lawes began his experiments.

Discovery of Superphosphate: In 1834, a little before the publication of Liebig's report, Lawes had begun his experiments on a small scale with pots and plants. During those experiments excellent results were obtained in the production of turnip crops by applying superphosphates, *i. e.*, mineral phosphate like apatite and coprolite dissolved in sulphuric acid, as manure. Previous to the discovery by Lawes, a mixture of bone and sulphuric acid had been used by Liebig as manure. The supply of bone available to the farmer was, however, rather small, while the supply of rock phosphate was enormous. The success of superphosphate led Sir John Bennett Lawes to take a patent in 1842 for the manufacture of superphosphate, and thus began the industry of artificial fertilizer which has revolutionized the agricultural world.

Usefulness of nitrogenous fertilizer: As a result of his trial and farming experience Lawes discovered, in opposition to Liebig's view, that a supply of combined nitrogen in some form or other was not only necessary to the crop, but on the whole determined its yield to a far greater extent than the supply of ash constituents.

Fixation of Nitrogen by Leguminous Plants and Inoculation of Soils with Nodule Organisms: In 1857 the subject of fixation of nitrogen was taken up at Rothamsted by Dr. Evan Pugh. His experimental plants were grown under glass shades, and every precaution was taken to remove any ammonia present in the air entering the shades. Ignited pumice or ignited soil was used. The results which Pugh obtained seemed to exclude the possibility of any fixation of nitrogen by living plants like wheat, barley, oats, clover, beans, peas, and buckwheat, and for several years the general scientific opinion was against the possibility of the fixation of nitrogen by living plants. The statistics of nitrogen collected by many crops in field experiments at Rothamsted and elsewhere, however, showed not only no decrease but an actual gain of nitrogen by the soil during the period when the leguminous crop was producing large quantities of nitrogenous matter above ground. These evidences and the long experience of farmers of the beneficial effects produced by growing clover and other leguminous plants in a rotation of crops led many investigators to think that there might still be a fixation of nitrogen by leguminous plants in spite of the contrary results obtained by Pugh at Rothamsted. The publication in 1886 of the researches of Hellriegel and Wilfarth cleared up the whole position. Their investigations showed that in sands the ordinary green plants grew almost proportionately to the amount of nitrogen supplied and that if the combined nitrogen was not added, nitrogen starvation set in as soon as the nitrogen of the seed was exhausted. In the case of leguminous plants however, when no combined nitrogen was added, sometimes a plant was observed to recover from the stage of nitrogen starvation and begin a luxurious growth, and the root of the plant was found to be covered with little nodules, characteristics of the roots of leguminous plants when growing under natural conditions. In further experiments the plants were grown in sterile sand without the addition of any combined nitrogen, and as soon as the stage of nitrogen hunger was reached, a small quantity of ordinary soil extract was added, and it was observed that the plants recovered from their state of nitrogen starvation assimilating considerable quantities of nitrogen. The renewed growth and the assimilation of nitrogen were observed to be attendant with the production of nodules on the roots, the nodules being full of bacteria (*Bacillus radicicola*). These bacteria could come only by previous infection. It was now evident that the extreme rigour with which Pugh carried out his experiments prevented any fixation of nitrogen by his leguminous plants since there was no chance of infection with the necessary bacteria. Also the utility of having a leguminous crop in rotation became clear. Subsequent experiments by Lawes and Gilbert showed conclusively that ordinary plant has no power of fixing nitrogen, but the whole class of leguminous plants form an exception, when grown under ordinary field conditions. Of the leguminous crops commonly grown, lucerne seemed to be the most effective in fixing nitrogen. It may be mentioned here that later works, elsewhere and at Rothamsted, on this line have led to the practical process of artificially inoculating the soil with the appropriate nodule organisms, which has proved very useful for the growth of leguminous plants, particularly of lucerne.

Classical experiments on wheat, barley, mangold, grass and on rotation of crops:— Among the many important experiments at Rothamsted are those on the continuous growth of crops like wheat, barley, and mangold. The idea of initiating these experiments was to test the practical question, whether artificial fertilizer can replace farmyard or whether they will in time injure the soil and the crop. It must be remembered that in those early days little was known as to the manurial requirement of any crop. The long duration of an experiment serves to remove many of the sources of error usually occurring in field experiments, such as the initial variations in the conditions of the plots due to previous manuring, and irregular attacks of insects and other pests. Moreover, by long continued experiments, the soil becomes exhausted of certain constituents and hence, only aftera number of years, the function of any element of manurial plant food is brought to light. Thus, by continuous growing of winter wheat in Broadbalk field (11 acres) since 1843, it has been shown that nitrogenous manures increase the yield of wheat very considerably and that nitrate of soda generally answers better for wheat than sulphate of ammonia. Results on the continuous growth of spring barley in Hoosfield (5½ acres) since 1852 show that the barley crop is far more dependent than wheat upon a supply of artificial manure which should contain a fair amount of nitrogen. Sulphate of ammonia has been found to be a better manure for barley than nitrate of soda, giving equal yield and generally superior quality. Barley is found to be particularly dependent on a free supply of phosphoric acid, 3 cwt. of superphosphate per acre may be profitably used on most soils.

Root crops like sugar-beet, swedes, mangold, turnip have always occupied a prominent place in Rothamsted experiments, and mangold is being grown in Barnfield (8 acres) practically continuously since 1876, and it is found that a liberal dressing of farmyard manure forms the best basis as manure for mangolds. The mangold crop will further respond to additions of nitrogenous manures to the dung and a supply of potash salts is essential. It may be remarked that the classical fields, Broadbalk, Hoosfield, and Branfield, have been divided into plots representing 18 to 40 different treatments, which have been maintained unaltered almost for the whole period.

Another classical experimental field at Rothamsted is Park Grass (7 acres) which has been growing grass for hay since 1856. This land has been in grass for at least 200 years. The field is divided into twenty plots which vary somewhat in size, between one-half and one-twelfth of an acre. Two of these plots have been kept unmanured throughout. The others have been kept under different manurial treatments from the beginning of the experiments and most of the treatments have been continued without any change. The investigation of the herbage is carried out from the botanical point of view and the herbage is generally separated into three groups—the grasses, the leguminous plants and the miscellaneous species. One important point which has come out from grassland experiment is that in order to secure the fullest development of those grasses and clover which are suited to haying and grazing respectively, the system of manuring once adopted should be varied as little as possible, for even manures as similar as nitrate of soda and sulphate of ammonia encourage the growth of different kinds of grass.

The classical Rothamsted Experiment on the rotation of crops is carried out on Agdell field (3 acres) which since 1848 is farmed on a four-course rotation of swedes, barley, clover (or beans) or fallow and wheat. It has been found that leguminous crops like clover and beans are dependent on the supply of minerals, particularly of potash and that the inclusion of a clover crop in the rotation, besides yielding a crop of hay, leaves the land so much richer in nitrogen that the succeeding wheat crop is considerably increased. With beans in place of clover no such beneficial effect has been observed.

Processes of Nitrification in soils: The experiments of Schloesing and Müntz in 1877 first established that the conversion of organic matter containing nitrogen into nitrates is carried out by living organisms. In about 1878, R. Warington at Rothamsted began further investigations into the question of nitrate formation in soil, in the course of which he found that the first product of oxidation was largely, if not wholly, nitrites, and that the nitrites were converted into nitrates at a later stage. Although Warington was not able to isolate in a pure state the organisms carrying on these reactions, his work showed that the process of nitrification in soils must be due to two distinct organisms, each incapable of doing the work of the other. Soon afterwards Winogradsky succeeded by a new method to prepare pure cultures of these two organisms and thus confirm Warington's conclusions. The experiments of Warington also showed that practically the whole of nitrification takes place in the first 9 in., which gets stirred about and aerated by the action of the plough. It was also realized that a bare summer's fallow is conducive to nitrification, the temperature of the soil being sufficiently high and the soil retaining sufficient moisture for ntrification, because the moisture is not used up by the growth of a crop.

The process of nitrification in soils has been followed at Rothamsted by estimating the nitrates in the water which percolates through drain-gauges. Such an examination would throw light on the rate at which nitrates are produced in soil, since all soluble compounds of nitrogen are retained by the soil except nitrates. It may be mentioned here that complete analyses of the mineral constituents of the water draining from various Broadbalk plots were made at various times by the late Dr. Voelcker and by Sir Edward Frankland; these experiments were done as early as 1866-68, and they still constitute almost our only information about the direct losses of the land by drainage.

At the time of the commencement of Rothamsted Experiments practically nothing was known about the combined nitrogen and other substances present in rain water. The determination of ammonia and nitrate in rain water was thought to be necessary in order to test the theory of Liebig that atmosphere was able to supply the ordinary crops with the necessary ammonia for its development, and has been carried out from 1853-54 onwards with occasional interruption periods. The chlorine and sulphuric acid in rain water have also been determined in many cases. The experiments showed that the average amount of nitrogen brought down by rain water from the atmosphere is about 5 lbs of total nitrogen per acre per annum. This includes the nitrogen present as ammonia, nitrate, and organic nitrogen in rain water.

Meteorological Observations: The rainfall has been measured at Rothamsted since February 1853, in a 5 in. funnel gauge and in a rectangular gauge (7ft. 3.12 in. by 6 ft.) having an area of one-thousandth acre. The amount of water percolating through bare soil has been measured since 1870 by means of drain gauges, each having an area of one-thousandth acre and of depths 20, 40, and 60 in. respectively. Barometric and temperature records have been kept since 1873 and since 1891 daily observation of the bright sunshine has been made by means of a Campbell-Stokes recorder. The average annual rainfall at Rothamsted is nearly 28. 3 in.

The Feeding Experiments: At the time when the Rothamsted Experiments were initiated not much was known about the laws of nutrition of animals. Boussingault was the pioneer in bringing into light the utility of non-nitrogenous constituents of food, but in general his conclusions were that the comparative value of food was determined by the nitrogenous rather than by the non-nitrogenous constituents of food. Liebig also regarded nitrogenous matter as the more important constituent of food. This was more or less the position of the science of animal nutrition when Lawes and Gilbert began their experiments on feeding. Their careful experiments with sheep and pigs indicated, in opposition to the prevailing impression, that it was rather the non-nitrogenous constituent of food which was more responsible than the nitrogenous constituent in regulating the amount of food consumed in a given time and also the increase in live weight produced. From their experiments on the fattening of pigs Lawes and Gilbert were able to demonstrate clearly that the animals put on far more fat than could be made up from the whole of the fat supplied in the food and the albuminoids in the food, and they were of opinion that at least 40 per cent of the fat of animal body could have come from the carbohydrates in the food. This view of Lawes and Gilbert was confirmed later by the experiments of Kühn and other workers.

Among the classical experiments on animal nutrition at Rothamsted were the chemical analyses of the whole carcasses of animals at various stages of growth. Indeed, up to the present time, these experiments form the fundamental basis of our knowledge of the composition of the animal's body and of the changes taking place during the growth and fattening periods.

Miscellaneous Experiments: The experiments of Lawes and Gilbert covered a wide range, such as experiments in investigating the application of sewage to land, experiments to ascertain the relative breeding value of malt and of barley from which it was made, experiments upon ensilage, the composition of wheat grain and the influence of weeds upon the wheat crops.

Amongst the numerous findings which have come out from the comparatively recent works at Rothamsted, mention may be made of two :

(1) Investigations by Russell and Hutchinson, on the biochemical processes of soil and directed to the discovery of the conditions under which the soil organisms live and work, showed that the micro-organic population must be regarded not as one but as two or more groups. One of these groups (soil protozoa) is detrimental to the useful organisms (soil bacteria) concerned in the process of ammonia and nitrate formation.

(2) Investigations on the secondary action of artificial manures upon the soil showed that the long continued use of sulphate of ammonia on soils, poor in lime, results in the soils becoming acid and the acidity is caused by certain micro-fungi in the soil, which split up the sulphate of ammonia and set free sulphuric acid. The usual bacterial activities in soil are suspended by the acidity and the remedy is the use of sufficient lime to keep the soil neutral. When nitrate of soda is applied to heavy soils, it is partially changed into carbonate of soda through the agency of plants and bacteria. The carbonate of soda thus originated deflocculates the clay particles and thus destroys the tilth of the soil.

Recent Development : Amongst more recent developments in Rothamsted Experiments, probably the most important is the application of statistical methods devised by Professer R. A. Fisher in the laying out of experimental plots and in examining the results in detail, taking due regard of the influence of weather and fertilizer efficiency. The utility of applying statistical investigations to farming operations is enormous. Indeed, Sir E. John Russell thinks, "With further developments it may be possible to work out tables for Expectancy of crop yield that could form the basis of a satisfactory crop Insurance business."

Acknowledgment

The thanks of the writer of this article are due to the Director of the Rothamsted Experimental Station, Sir E. John Russell, for his kind permission to write this article with the illustrations included herein. The informations were obtained from the following publications :

(1) *The Rothamsted Experiments over fifty years*—By J. B. Lawes and J. H. Gilbert, 1825. (2) *Book of the Rothamsted Experiments*—By A. D. Hall, revised—By E. J. Russell, 1917. (3) *Agricultural Research Institutes and Agricultural Colleges*, I. The Rothamsted Experimental Station, —By E. J. Russell, Superphosphate, 1930, Vol.3. pp. 149-157. (4) *Soil conditions and Plant growth*—By E. J. Russell, 1932, pp. 1-31. (5) *Guide to the Experimental Farm, Rothamsted Experimental Station*, Harpenden, Lawes Agricultural Trust.

Physics in the Melting-pot

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NOTWITHSTANDING the craze for evolutionary theories, scientists and philosophers alike prefer to speak of real revolution, or rather a series of revolutions, which have shaken, down to its foundations, the stately scientific edifice erected, at the cost of much labour, in the course of the nineteenth century.

When people nowadays speak of the progress and changes in science, and more especially in physics, they do not mean the ordinary, classical physics, which studies events more or less on our own scale, but macro- and micro-physics, where everything is on a scale either immensely larger or incredibly smaller than our own. A few years ago Einstein's relativity theory was foremost in their minds; the wind has now turned towards the quantum theories of atomic and sub-atomic physics.

Whilst practically the whole relativity theory in its various stages proceeded from the brain of Einstein alone, the quantum theory, in its different aspects and successive transformations, is the work of many eminent scientists hailing from many different nations. It is, however, true that, as the general title of the theory indicates, the various steps of its development were all dominated by that fundamental notion of the quantum of action, Planck's famous constant $h = 6{\cdot}55 \times 10^{-27}$ erg-seconds.

It was at the opening of the present century that Planck proposed the original and revolutionary theory which alone succeeded in explaining, in their entirety, the various phenomena of radiation. Planck's fundamental assumption is that bodies can emit or absorb energy in the form of radiation (*e. g.*, heat or light waves) only in definite discrete quantities. Radiations being considered as propagating in the shape of waves and therefore having one or more determined wave-lengths and frequencies (ν), Planck stated that the amount of energy emitted or absorbed at a given time is necessarily equal to the *quantum of energy*, $h\nu$, or an integer multiple of it: hence the smallest parcels of energy that can be emitted or absorbed vary with the frequency of the wave.

Planck only considered the emission- and absorption-process of radiating energy, but the question naturally arose why we should not suppose radiating energy also to travel in the shape of packets of energy, instead of spreading out evenly in all directions as waves do. This argument of uniformity received strong confirmation from direct observation. It is well known that the human eye or a photoelectric cell responds in a small fraction of a second to even the faint light of a candle suddenly lit at a considerable distance. If radiating energy were spreading out from the candle in the shape of waves, calculations show that a sodium cell, at a distance of 3 metres, would require four hours before it could start emitting electrons as a result of the illumination, whereas in reality the photo-electric current starts in less than three-thousands of a millionth of a second (3.10^{-9}secs). Since the reaction of the eye, or of the cell, and hence absorption, is practically instantaneous, it seems likely that radiating energy is not only being emitted and absorbed but is also travelling in the shape of packets of energy. Once again it is Einstein who in 1907 made the bold assertion that we must give up the century-old idea that light, and in general all radiating energy, travels in the shape of waves, and that we must rather consider light-quanta or *photons*, of value $h\nu$, as being the carriers of the energy from emitting to absorbing bodies. This was a return to Newton's corpuscular theory of light, although Newton would probably have found it hard to recognize his own child in its new garb. One characteristic of this new theory which should be noticed is that, although it does away with the notion of waves, it keeps as an essential factor the notion of frequency, ν, which receives a physical meaning only in a wave or some other periodically varying mechanism.

Lorentz, the great champion of the electronic theory, had already proposed a theory which considered the oscillations of the electrons inside the atoms as the origin of the electro-magnetic waves to which Maxwell had reduced the nature of radiating energy. In the beginning of this century Lord Rutherford's investigations on the radiations from radioactive substances led him to conceive the atoms as consisting of a heavy nucleus, carrying practically all the mass and charged with positive electricity, around which gravitate in different orbits a number of electrons, so that the whole is electrically neutral, except very near the nucleus where the positive field of the concentrated nucleus prevails. N. Bohr in 1913, taking Rutherford's atom as his starting-point together with Planck's quantum rules for the emission and absorption of radiating energy, proposed his own model of an emitting atom: the electrons are still gravitating around the nucleus according to the classical rules, but, contrary to those same rules, these non-uniformly moving electrical charges do not emit any energy in the shape of electro-magnetic waves; further, only a certain number of orbits are allowed, determined by the quantum conditions, and only when, for some reason or other, one or more electrons are temporarily disturbed in their circumvolutions is some energy radiated by the atom; and, similarly, the absorption by an atom of radiating energy corresponds to an electron-jump from one orbit to another. The emission and absorption of radiating energy being regulated by quantum rules, it follows that there must be a difference of exactly one quantum of energy between the different amounts of energy stored up in an atom according as its electron or electrons move on one or other of the quantized orbits (*i. e.*, the orbits allowed by the quantum rules). As different electron-jumps are possible, several values are possible for the emitted quantum of energy, ($h\nu$), hence there are various values of ν which explains the line-spectrum of the elements.

This hybrid model, with its curious mixture of classical and quantum rules, met from the start with unparalleled success, because this was the first time that the enormous amount of spectroscopic data could be interpreted in a synthetic way; and at the same time many more spectroscopic facts were thus foretold and soon after verified, chiefly when Bohr's theory had been further developed by Sommerfeld's relativity corrections. This theory also gained great popularity with the chemists, who found in it a satisfactory interpretation of Mendeléeff's periodic classification of the elements. For about twelve years a complicated but impressive structure was being erected on these foundations laid by N. Bohr.

The enormous development of the researches on atomic and molecular spectra all over the world brought in such a wealth of material that very soon the original Bohr model proved insufficient to cope with it. After some theoretical improvements and additions, the theory had to be patched up by means of empirical or semi-empirical rules, outstanding among which are the *selection rule*, which forbids some of the electron-jumps for the simple reason that they correspond to none of the observed spectral lines, and *Pauli's verbot*, which for similar reasons forbids any two of the electrons gravitating around the nucleus in an atom to be in exactly the same conditions. At the same time the pictorial representation of the original model was gradually lost sight of, only the original expressions being kept to represent various energy states in the atom, without any attempt to interpret these by some ordinary mechanical structure.

Many leading scientists had repeatedly protested against the numerous inconsistencies which had gradually crept into Bohr's quantum theory of the atom; but little attention was paid to them because of the incredible success of this theory in interpreting so many and varied phenomena, and, presumably, also for want of a more satisfactory one. This feeling of uneasiness gradually waxed stronger, until about the year 1925 the brilliant minds of several young scientists set seriously to work to find a way out of the impasse.

The lead for a new revolution within the quantum theory itself was given almost simultaneously in different countries and apparently from absolutely different points of view.

Heisenberg definitely declared that Bohr had attempted too much : instead of limiting himself to the direct facts of observation about the emission and absorption of radiating energy and the spectroscopic determinations connected with it he, and others after him, had devised a complicated system of electrons *inside* the atom whirling round the nucleus according to increasingly complicated rules. What right had he to lay down the laws which shall preside over the internal life of the atom? No wonder that such arbitrary assumptions led to numberless inconsistencies and contradictory statements. Heisenberg therefore proposed to abide strictly by the observed facts ; the frequencies and intensities of the spectral lines which necessarily correspond to some change inside the atom from one energy state to another : these various data are represented by mathematical expressions and then grouped in a special arrangement called a *matrix*. By applying the methods of matrix-calculus, Heisenberg created a new quantum mechanics, which explained the experimental data as well as, and often better than, Bohr's theory, and which also led quite naturally to the various postulates which Bohr had arbitrarily introduced.

Almost at the same time Dirac, at Cambridge, proposed his own mathematical quantum theory, still more abstract than the one of his German colleague ; but the two theories were soon found to be fundamentally equivalent.

Hardly a year later, the problem was approached from a different angle by Prince L. de Broglie, and further developed by Schrödinger. For a long time de Broglie had been puzzled by the dual aspect of the wave and the particle theories of light recently brought to the fore again by Einstein's photons: these two apparently contradictory theories are both indispensable to explain one or more aspects of the numerous optical phenomena. L. de Broglie's bold solution was to extend this dual character to matter as well : electron-rays or atomic rays, so far considered as jets of material particles, might, in certain cases, be considered as waves, so that the particles whilst travelling are, so to say, accompanied by, or embedded in, waves. Considerations drawn from classical optics, in particular from Fermat's principle, together with Planck's fundamental radiation-formula, enabled him to deduce the value of the frequencies of such matter waves : they were found to be of the same order as X-rays. Schrödinger greatly improved this theory by discovering the true wave-function to be attributed to these mysterious waves, his now famous ψ function."

As soon as the superiority of this new wave mechanics over the old quantum theory had been definitely proved, great activity animated all the research laboratories on atomic physics : would it be possible to produce direct experimental evidence of the reality of these matter waves? It is sufficiently known how, almost simultaneously in various countries, diffraction figures were obtained by passing electronic rays through crystals, which were in every way similar to those obtained with X-rays.

Luckily Schrödinger was able to prove mathematically the equivalence of Heisenberg's calculations and his own replacement of ray-mechanics by wave-mechanics. A further step was the exact determination of the meaning of ψ, the wave-function which governs and determines the motion of electrons and other material particles as light waves determine the motion of the photons. As in the various wave theories of light, here also the difficulty was to find a subject for the verb 'to vibrate'. In the case of matter waves, Schrödinger first suggested that the wave function represents the density of the electric charge along the path, or around the nucleus, in case we consider electronic waves as replacing Bohr's electronic orbits inside the atom. According to this intrepretation, therefore, the electrons or other material particles have no reality of their own except when many waves by interference produce nodes and loops of density, the loops corresponding to what we used to call electrons. This interpretation of the wave-function was open to many serious objections ; hence M. Born proposed to explain the dual nature of matter and radiation by assuming that ψ, Schrödinger's wave-function which periodically varies with time and place, represents the probability of an electron being in a given place at a given time ; and, therefore, in the case of a great number of electrons, the crests of the waves represent the places and time where and when there will be a great concentration of particles. According to this interpretation, which has gained increasing popularity, the electrons are given back their reality, but the waves possess no more than a mathematical existence, which brings wave mechanics nearer to Heisenberg's and Dirac's statistical quantum mechanics.

The interpretation of the de Broglie waves as probability-waves is quite in conformity with Heisenberg's epoch-making discovery, in 1927, of the *uncertainty principle*, which he proved to underlie the new quantum mechanics. Even ordinary mathematical reasoning shows that, according to the general quantum principles, it is impossible to determine exactly both the position and the velocity of a particle at a given moment : the greater the precision reached in determining the one, the greater the uncertainty in determining the other : the product of the two uncertainties being always equal to $h/2\pi$, thus Planck's constant once again asserts itself as the ultimate key to all quantum theories. This uncertainty principle is in fact almost self-evident, for to determine and measure, say, the position and velocity or momentum of a body, we must look at it and thus in some way alter its conditions, since our looking at it influences it ; this is, of course, noticeable only in the case of very small particles, which have to be observed by means of very powerful radiations : these so disturb them that it is impossible to obtain any accurate information (on the quantum scale) about their position or momentum.

The introduction of probability-waves in conjunction with the uncertainty principle does not mean that the whole physical world is ruled by chance and chaos, for we have seen that the uncertainty itself is very limited : only to people like Maxwell's demon or observers of the dimensions of Planck's quantum does the physical world appear absolutely topsy-turvy. Yet who knows what other observations and theoretical considerations such a minute observer would make which would fill him with wonder, or perhaps indignation, at those big beings, called men, who dare assert so many and so strange properties of the world of micro-physics, which is not at all on their scale ?

This naturally leads us to the philosophical discussions provoked in the minds of both scientists and philosophers by the above-mentioned revolutions in physics. It is claimed that nowadays no philosophy is complete which does not take into account these latest findings of physical science, because these seem to have a direct bearing on philosophy, in particular on the epistemological problem which is at the basis of any sound philosophical system.

We are far from the absolute self-confidence of nineteenth-century scientists : the theories which then seemed most firmly established have been questioned and even replaced by more accurate ones, and what appeared to be the very foundation of all scientific inquiry—the principle of causality and strict determinism in nature—seems to have received a definite set-back from Heisenberg's uncertainty principle.

A natural reaction with many non-scientists as well as a certain number of scientists is to deny any real value to all the findings of science, to declare that it is mere imagination and symbolism, a display of intellectual jugglery by overheated mathematical brains !

But if we go too far in that line, very soon experience itself will deny these charges ; classical physics in particular will appeal to the innumerable practical discoveries which were the direct outcome of its theoretical laws and principles, and modern physics is equally firmly based on direct experimental evidence. Shall we, therefore, conclude with Poincaré, and many others after him, that scientific theories have value in so far as they prove useful ? To say the least, these theories are great economizers of thought and prove efficient tools in the hands of skilled scientists.

Does not the fact that science has a true value for life, practical as well as speculative, imply that it contains at least some elements of truth ? Is everything in science merely symbolical, telling us nothing about the reality of things ? One might be inclined to think so, chiefly after reading about the latest quantum theories, which have a worthy precursor in the thermodynamic theories with their statistical considerations and the mysterious entropy notion.

However, even those scientists who are most insistent on the symbolical aspect of scientific theories assert equally strongly that there must exist some correspondence between our mental world-picture and reality. The difficulty is to sift the chaff from the grain, to determine what is symbolical and what is real, or rather to discover in the symbolic representation itself what refers to the reality of things. On this point various '*isms*' oppose each other: positivism, the solution of the narrow-minded, solves the problem, or rather renders it non-existent, by denying one of the two factors: positivists declare that it is mere illusion to speak of the world outside us, since nature is nothing but our very sense impressions which constitute the whole of our knowledge.

Nowadays scientists generally agree that in the knowledge we acquire about the physical world it is an illusion to try to distinguish between the thing observed or measured and the observer or the measuring instrument: what we know is the combined result of both: this assumption also underlies the physical interpretation of the uncertainty principle. This general consideration is developed in one line or another, and thus we are presented with different speculations about 'the physical nature of the world'. Eddington insists much on the part taken by the mind in constructing our picture of the universe, and defends a position which borders on absolute idealism. Planck, on the other hand, places full confidence in a sound realism: in his popular lectures and books he constantly reaffirms the absolute necessity of maintaining that real events do happen independently of our senses perceiving them. To him it is evident that the only way of avoiding an irrational solipsism is to assume 'that the functional relations between sense data contain certain elements not depending upon the observer's personality nor upon the time or place of observation'. If it were not so, Planck argues elsewhere, how is it that all men's brains construct exactly the same moon and sun and stars? By similar arguments Planck advocates the maintenance of the principle of causality, which he, however, explains in a way modified in the light of Heisenberg's principle. At the same time he upholds the notion of free will, and claims that it is not irreconcilable with the idea of a strict causality regulating everything in this world, because to him free will can only mean that the individual *feels* that he is free; but this leaves open the question whether an ideal spirit might not fully comprehend the motives which entirely determine his actions.

This is a striking illustration of the weak point in Planck's philosophy, and in most of the philosophical musings of modern scientists. They themselves repeatedly assert that it would be rash and impertinent for them to dabble in philosophy; yet many of them give in to the temptation. Nor are they to be blamed for it, because as men they have as much right to philosophize as anybody else; but they are wrong when they want to examine and criticize philosophical problems and theories according to the principles and methods of empirical science. It may be quite lawful to banish metaphysics from science; but then might not philosophers return the compliment? This does not mean that metaphysicians should lock themselves up in their ivory tower of apriorism, ignoring the progress made in the empirical investigation of the physical world. They can derive from it much valuable material for their study of the working of the human mind, and this in turn may throw some light on the obscure problem of epistemology and at the same time supply them with much information about the physical world and the nature of material beings in general. But such studies on the ultimate nature of things have to be carried out according to the rules and principles proper to such investigations, I mean, according to the methods of philosophy; for if many have loudly protested against the Scholastic saying that philosophy is to be the handmaid of theology, would it be any better if she were now given another master in the person of empirical science?

Synthetic Plastics

(Continued from the last issue)

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Cellulose Plastics

Long before the synthetic resins were known, cellulose plastics were manufactured and used on an industrial scale. Recent years have however seen an enormous increase in the use of cellulose derivatives as plastics. Properties of different cellulose compounds and their methods of manufacture have been improved and a wide field has been found for their industrial application. Celluloid, cellulose acetate, viscose, and other derivatives are used as reversible thermoplastics, so that they can be easily welded together either by heat and pressure or by means of solvents, enabling complicated forms to be made with ease. Unlike the synthetic resins, no hardening or chemical change takes place in the mould and hence there is no risk of premature hardening or of discolouring during the moulding operation, which can be completed very quickly and is therefore very economic. They can be moulded either in the form of powder or of slabs and are also suitable for the injection process whereby the heated material is passed under pressure through an orifice into the mould which is kept cool. This process enables intricate objects to be made from cellulose derivatives.

Celluloid—Of the different synthetic plastics, celluloid is perhaps most widely used, the world production being about 50,000 tons per annum. It was first prepared in 1869 by Messrs. J. W. & J. S. Hyatt for the purpose of manufacturing billiard balls. To-day it is used for a large variety of purposes. Brushes, combs, dolls, films photographic outfits, accumulator cases are manufactured from it.

It is made by nitrating cellulose to pyroxylene having a nitrogen content of about 11%. The product is transformed into a jelly by kneading with camphor and alcohol. On partial removal of the solvent, the material can be given any desired shape when the remaining solvent is finally removed. Camphor plays the role of plasticizer or softener, imparting flexibility, non-brittleness, and thermoplasticity. Celluloid is capable of being moulded into shape at about 100°C and is resistant to water and dilute acids. Its inflammability is however a deterrent for its more extensive use. Moreover, it is discoloured by continued exposure to the sun and does not stand high temperature. For these reasons it has largely given place to cellulose acetate in the manufacture of cinema films, aeroplane dopes, and safety glasses.

Cellulose Acetate—The greatest impediment to the development of cellulose acetate plastics was the great cost of its production but in recent years great improvements have been made in the manufacturing technique, which have reduced the cost of production while improving its properties. Cellulose acetate was first made by Franchimont in the year 1879 by acetylating cellulose in the presence of sulphuric acid. The method has since been improved only in details and modern manufacturing process consists in acetylating cotton linter with a mixture of acetic acid and anhydride in the presence of suitable condensing agents under rigid temperature control. It is then subjected to a ripening process for several days and the product is precipitated by mixing with water and other media. As in the case of celluloid, the use of plasticizers is necessary, though their nature is altogether different, and here a mixture is usually preferred. The material is either brought into solution to be evaporated into films, foils, and glass substitutes or is kneaded with a limited amount of solvent together with plasticizers, filling and colouring materials to be formed into slabs or blocks. These slabs, powders, or chips are heated on a steam table and then introduced into hot moulds which are almost immediately cooled. When the form to be made is complicated, the injection process is usually used.

The acetate is not inflammable and stands sunlight and high temperature much better than celluloid. Its high dielectric strength and insulating capacity make it eminently suitable for the manufacture of all kinds of electric goods. Hardness, flexibility, glaze, etc., can be altered by changing the amount and nature of plasticizers and filling materials. Modern safety glasses are almost exclusively made of cellulose acetate as it transmits ultraviolet light in sun's rays, and is not brittle. By careful choice of colours and pigments, it may look either crystal clear or like imitation mother-of-pearl and marble. It can be machined, cut and sawed like wood, and is used for boxes, vanity sets, lamp shades, etc., and in the form of foils it is largely used as a wrapping paper for foodstuff which is protected from moisture and dirt. As is well known, it is also extensively used in lacquer industry and in the manufacture of artificial silk.

In recent years great expansion has taken place in the use of the acetate as a plastic material. In the year 1931, only 100,000 lbs were used for this purpose in U. S. A. but in 1934, this figure rose to 4,830,000 lbs and in 1935, to 10,500,000 lbs! In addition, about 60 million lbs of acetate are used for other purposes, such as artificial silk and cinema films.

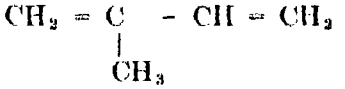
Of the other cellulose plastics, mention may be made of viscose and benzyl cellulose. The former, well known for its artificial silk, is also used for the manufacture of buttons, wrapping papers, and bottle caps, while the latter is valued on account of its resistance to water, alkali, and acids not only in the lacquer industry but also as a thermoplastic capable of standing high temperature. Its cost of production is however high and if its price could be sufficiently reduced, it would receive extensive application in industry.

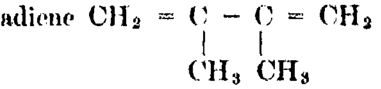
Synthetic Rubber

Another plastic material—synthetic rubber—is gradually becoming a serious rival to the natural product. The search for rubber substitutes was first undertaken owing to a serious rise in the price of natural rubber a few years before the War, and owing to national emergency, its large-scale manufacture was undertaken in Germany during the Great War. On account of poor quality and high cost of the synthetic product, its manufacture was abandoned after the War was over. Investigations into the possibilities of suitable rubber substitutes were however continued and received fresh stimulus from the high price of natural rubber prevailing in post-War days. Though the price fell later to a considerable extent, investigations were continued and notable success was achieved by two companies —the I. G. in Germany and the Du Pont in U. S. A. and to-day these substitutes are again being produced on a large scale in U. S. A. and Soviet Russia and to a smaller extent also in Germany. America produces mainly the "Chloroprene" or "Duprene" rubber while Russia the "Butadiene" rubber. The cost of these synthetic products is however much higher than that of the natural product. Unless the cost can be substantially reduced, its use cannot be expected to be as extensive as that of the natural product. The qualities of the synthetic product have however been so much improved that to-day it not only equals but in some respects is even superior to natural rubber.

The following hydrocarbons containing the conjugated double bond have been found to give rubber-like products on polymerization :—

Butadiene $CH_2 = CH - CH = CH_2$

Isoprene 
$$CH_2 = \underset{\displaystyle CH_3}{\underset{|}{C}} - CH = CH_2$$

2 : 3 Dimethyl butadiene 
$$CH_2 = \underset{\displaystyle CH_3}{\underset{|}{C}} - \underset{\displaystyle CH_3}{\underset{|}{C}} = CH_2$$

During the Great War, attention was directed to the manufacture of 'methyl' rubber from 2-3 dimethyl butadiene as it was found to be superior to those obtained from butadiene or isoprene. The raw material, 2-3 dimethyl butadiene, was prepared from acetone by reduction with aluminium amalgam to pinacone from which water was eliminated. The acetone required for the purpose was at first made by the fermentation of potatoes, but as this was an important article of food, it was later made from calcium carbide. Three processes were mostly followed for polymerization, *viz.*, (1) polymerization at low temperature for 4 or 5 months which gave a hard variety, (2) polymerization at high temperature (70°C) which gave a soft variety, and (3) polymerization at ordinary temperature with metallic sodium as a catalyst in CO_2 atmosphere which gave a product capable of being milled and extruded. The polymers obtained by all these three processes, when vulcanized in the usual manner, gave products of poor quality. In strength and elasticity they were much inferior to natural rubber and would soon deteriorate owing to oxidation in air, and their plasticity was so small that they could hardly be milled and extruded—a process so necessary for the formation of rubber goods.

The process of vulcanization was much improved by the introduction of 'accelerators' such as piperidinium pentamethylene di-thiocarbonate, formed by the action of piperidine on carbon disulphide. This substance not only accelerates vulcanization and makes more sulphur enter into chemical combination but also serves to prevent deterioration due to oxidation. Since then, a large number of other antioxidants and accelerators have been introduced while the use of 'plasticizers' like dimethyl aniline, toluidene and other substances made the material more plastic and capable of being milled.

In the post-War days great improvements have been made both in the preparation of raw materials as well as in the methods of polymerization. But perhaps the most important improvement has been the discovery that incorporation of carbon black with the synthetic product greatly increases its tensile strength which approaches the strength of natural rubber.

Great improvements have also been made in the processes of polymerization which may be effected either in mass or in emulsions. Polymerization in mass follows generally the methods developed during the War, but the use of Na-K alloy in place of metallic sodium in nitrogen atmosphere as well as other organic and inorganic catalysts have greatly reduced the time required for polymerization, while the presence of starch and cellulose ethers and other substances such as venyl-ethyl-ether and dioxane during polymerization has greatly improved the quality of the products, particularly its plasticity. Similar results have been obtained by introduction of chlorine compounds and certain bases like ammonia, aniline, and their derivatives.

Attempts to imitate nature in the production of artificial rubber has produced very encouraging results. It is known that rubber latex consists of an emulsion consisting of about 35% rubber, the rest being water, proteins, resins, and salts—the size of the particles ranging between ·5 μ to 3 μ. The idea of imitating nature by polymerizing in emulsions occurred even before the War but it is only in recent years that great success has been achieved in this respect by the I. G. in Germany. In the presence of suitable catalysts, emulsions have been found to polymerize very rapidly and at low temperature so that the formation of oily by-products associated with heat polymerization was avoided and high yields were obtained. This synthetic latex can be concentrated to pastes and then diluted again with water or can be coagulated like natural latex. The particle size in these synthetic emulsions is smaller and lies between ·05 to ·2 μ.

The 'diene' hydrocarbons are emulsified with the help of soap, sulphonic acids and their salts, bile acids, etc., and are then allowed to stand in the presence of various catalysts such as hydrogen peroxide, organic and inorganic per-salts, ozonides, and various organic halogen compounds. While the polymerization process required several months in War time, it can now be completed in a few hours. In these emulsions, gum arabic, casein, etc. are often added as protective colloids while addition of various electrolytes and plasticizers improve the quality of the product.

It should be remembered that natural rubber is a heterogenous substance, being a mixture of various polymers of different sizes. Imitation of nature in this respect has met with considerable success and the quality of the synthetic product has been greatly improved by mixing different polymers obtained by different methods of polymerization or by conducting the polymerization of more than one substance simultaneously.

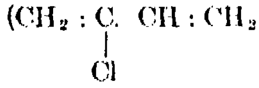
Russian Synthetic Rubber

It is said that large quantities of synthetic rubber are being made to-day in Russia using butadiene as a raw material, about 25000 tons having been produced in the year 1935. Butadiene is made by the pyrolysis of alcohol in the presence of catalysts such as a mixture of alumina and zinc oxide and is polymerized by the metallic sodium method. The yield of rubber is said to be about 25% on the alcohol used. Details regarding quality are not available but it has been reported that tyres made from it have given a milage up to 27,000 Kilometers under Russian conditions. The cost of production is apparently very high but is not a matter of concern under the Soviet system.

American Chloroprene Rubber

The year 1931, the Du Pont Company announced the discovery of a synthetic rubber made from 2-chloro 1, 3 butadiene. In elasticity, extensibility, and strength it is said to be equal to natural vulcanized rubber and in certain respects it is even better than natural rubber. For example, it is much less susceptible to deterioration by oxidation, is more resistant to organic solvents, and does not loose its strength in contact with mineral oils as natural rubber does.

The preparation of chloroprene and the method of its polymerization are much simpler. Acetylene is polymerized to venyl acetylene $(CH_2 : CH.\ C \vdots CH)$ in the presence of cuprous and ammonium chlorides. By adding a molecule of HCl, it gives 2 chloro 1.3 butadiene $(CH_2 : \underset{\underset{Cl}{|}}{C}.\ CH : CH_2)$. Being a halogen derivative, it polymerizes much more readily than isoprene and hence the preparation of synthetic rubber from it takes only a few hours in contrast with several months required for the manfuacture of rubber from "diene" hydrocarbons during the War time. When the polymerization is complete, the material becomes hard and non-plastic (μ-polymer) similar to vulcanized natural rubber. If partly polymerized, it is obtained in a plastic form (α-polymer) similar to unvulcanzied raw rubber and can be manipulated like it. The plastic α-polymer can be converted into μ-polymer by heat when it becomes elastic and insoluble like vulcanized rubber.



Polymerization is effected either in mass or in emulsions. In mass, the α-polymer is obtained by polymerization to the extent 30% by exposure to a mercury arc lamp at a temperature of about 35°C and then removing the unchanged monomer. It is converted to the μ-polymer either by keeping it for 2 or 3 days at ordinary temperature or by heating to a high temperature for a few minutes.

In emulsions chloroprene is polymerized at a low temperature. The rate of polymerization is so high that it is difficult to control the process which tends to produce the μ-polymer. Chloroprene emulsified with sodium stearate or other emulsifying agents is allowed to stand at ordinary temperature when large amount of heat is evolved and the process is completed in a few hours producing a vulcanized latex which can be stabilized by the addition of a little ammonia.

The character of the polymer and the rate of polymerization can be altered at will by the addition of suitable substances. The conversion of the α- to the μ-polymer is accelerated by addition of several salts and aromatic amines which thus resemble the accelerators used in the vulcanization of natural rubber.

Owing to the great tendency of chloroprene and its plastic α-polymer to polymerize even at ordinary temperature, its large-scale manipulation would have been impossible without the discovery of inhibitors. It has been found that in the presence of polyphenols, amines, etc., chloroprene remains in the liquid state for an indefinitely long time and the conversion of the α-polymer to μ-polymer is retarded by secondary amines such as phenyl β-naphthylamine. If this inhibited α-polymer be heated to 100°C, the inhibiting effect disappears and the conversion of α- to the μ-polymer proceeds smoothly. This discovery is of great importance as it enables us to keep the α-polymer in plastic state for any reasonable period of time and can then be converted to μ-polymer when desired. It has been estimated that about 200,000 lbs of this chloro-rubber is manufactured in U. S. A. per annum.

Koroseal

Another rubber-like substance has come into the market from U. S. A. under the name of Koroseal which is made by polymerizing venyl chloride. By regulating the course of polymerization, its properties can be varied from those of hard rubber to a rubber gel. It can be incorporated with plasticizers, filling materials and pigments. Like chloro-rubber, it is superior to natural rubber in its resistance to oils and solvents and freedom from attack by air. Tyres made of this material have been found superior to those made of natural rubber by actual road tests. In addition, it can be used as a thermoplastic and hence can be used over a wider field.

A Plea for the Development of the Thermoplastic Industry in India

It has recently been annouced in the daily papers that the Industrial Research Bureau have appointed a sub-committee to investigate the pros and cons of using casein as a thermoplastic. Milk, unlike many other commodities, is an article which cannot be preserved for a long time, and in certain rural areas the extremely poor peasants have to dispose of their milk at a ludicrously low price. If a demand can be created for the milk-product casein by converting it into a thermoplastic, it will mean a great economic relief to the poor agriculturists. The effect of using such an important article of food for industrial purpose on the health of the population should however be investigated and the appointment of the sub-committee to investigate this point is therefore a move in the right direction.

It has been reported that India imports celluloid goods worth more than 1.5 crores of rupees per annum. The celluloid factories in this country, so far as the author is aware, import their celluloid in mass from abroad, mainly from Japan, and merely knead this imported material with solvents and mould it into shape. It is difficult to understand why the pyroxylene necessary for the purpose should not be manufactured in this country when all the raw materials except perhaps camphor are available here.

A few moulding factories using moulding powders imported from abroad have recently been established in this country and their products have attracted great public attention. Figures indicating the value of the imports of synthetic resin articles are not available but considering the extensive field for their use, these figures will certainly be very high. There is no risk that the synthetic resins, if developed in India, will compete with indigenous shellac. The synthetic resin industry is now consuming more and more shellac and for this reason the demand for shellac has increased in recent years. It is said that Japan developed her celluloid industry in order to create a field for her camphor which was threatened by the synthetic material. One of the means of creating a market for Indian shellac would be to develop a synthetic resin industry which would consume this important indigenous product and not serve as its rival. It is also likely to create a market for inferior cotton and other fibres for which there is at present not much demand.

The raw materials are not difficult to manufacture in this country. Coal tar and methyl alcohol necessary for the manufacture of phenol and formaldehyde are abundant. Urea and thiourea can easily be made from calcium cyanamide and ammonium sulphocyanide. Coal tar also supplies naphthalin which can be easily converted into pthalic acid. Glycerine and unsaturated acids are obtainable from the abundant supply of indigenous vegetable oils and the manufacture of glycerine can be undertaken with confidence if its price remains steady and its demand in peace time be assured. Indian labour is reported to be particularly skilful in moulding industries and India offers a large and ever-increasing market for these products while internal competition—at least for the present—is practically absent. There is no reason therefore why India should not have a prosperous plastic industry of its own. To-day every civilized country is developing this industry and once India falls behind in this international race, it may soon be impossible, without Government coming to the rescue, to make good the ground lost now.

Illumination—Past and Present

P N. Ghosh

Ghosh Professor of Applied Physics, Calcutta University.

THE very earliest impression of the dawning intelligence of those beings who were the antecedents of men must have been the consciousness of the difference between light and darkness. They evidently associated darkness with danger and evil as they were unable to react effectively to their surroundings. In the concept of creation as evinced in the different literatures of the East as well as of the West one finds the starting point to be a stage of dismal darkness spreading over the whole globe, such as, *asīdidam tamobhūtam* or "In the Beginning there was Nothing", but the merciful Providence desired the appearance of light—"God said 'Let there be Light' and there was Light". Such have been the early traditions indicative of an attempt to secure for man the beneficent light and illumination.

From the remains of the earliest traces of man, one finds, besides other things, also articles used to lighten his darkness. Amongst the wonderful discoveries made in the excavations at Ur of the Chaldeans in Mesopotamia, one finds oil lamps of beautiful designs dating from nearly 4000 B. C. revealing a civilization older than that of Egypt. Lamps found near the earthly remains of one of the Sumerian queens, named Shub-Ad, are in the form of shallow, open bowls with the usual long lips for the wicks to rest in. Some of the lamps are of gold of a heavy fluted design, the workmanship would do credit to any present-day metal worker and is indicative of a technique hardly suspected to be prevalent in so remote an age. All these lamps must have been used in their life-time and were placed by the sides of their owners at death, to help them in their passage from this world to the next. The dates of these lamps have been ascribed by archaeologists to be about 3500 B. C. That is nearly 6000 years ago.

If we are permitted to peep into the dim ages of the past when man with same nature and feelings as ours lived, loved, worked, and died, we find him facing the same illumination problems as we are doing to-day, seeking to regulate the light of the day to enter his habitations and to supplement it at night as effectively as his knowledge would permit. Reviewing our position regarding illumination we find that from 4000 B. C. to nearly 1800 A. D. close upon 6000 years his knowledge did not take him further than the use of a wick dipped in oil or of a candle made from waxes and fats. In the East, the land of tropics, evidently in some distant remote age the discovery of the oil-seeds, besides providing man with his natural food, supplied also his illuminant for the night. In fact, oil was the universal illuminant of every household, of every religious sanctuary, or of public places of worship. In the West not favoured with vegetations yielding the necessary oil, the properties of the bee-wax and tallow candles were similarly discovered. In the West so far as one can get from the records, from about 1500 to 1800 A. D. candle was the principal source of light. Every household had its stock of the candles and everyone used to carry a candle even to his bed side. In many countries the production and use of these candles were supported by the State and in London the Worshipful Company of Tallow Chandlers flourished under Royal Charter. They have still got their society at its Guild-Hall, at Dowgate-Hill in the city of London.

Besides the tallow, the blubber of sperm whale, the so-called spermacetti, was the common wax for candle manufacture. Kings and nobles used to derive large income from its trade. Thus in the port of Bremen in the 16th century one finds among the records a tax imposed on this wax amounting to 15000 gold coins. Such has been the history of the illuminant of the middle ages. The progressive West in its search for fuel discovered the mineral coal which forms a landmark in the history of civilization. It brought in its train the steam engine, the metallurgy of iron and other mechanical inventions characteristic of the latter part of the 18th century.

Gas

In the *Philosophical Transactions* of 1739-40 of the Royal Society of London we find a reference of the researches of John Clayton, D. D., who showed that coal burnt in an enclosure gives out a gas which could be lighted—the first reference of a new illuminant brought to the notice of man. But it was William Murdoch to whom is ascribed the practical application of coal gas to domestic lighting. He lighted his house in Red-Ruth, Cornwall, in 1702. It, however, took not less than 40 years to utilize this type of lighting for public-street illumination. It may be mentioned in this connection that the practice of public-street lighting is by no means confined to modern times. The Greek historian states that the streets of Antioch were lighted in the 4th century B. C. and it is further recorded that in 550 A. D. the Roman Governor of Edessa took some of the oil from the churches in order to keep the street lamps burning all night. In fact, even during the middle ages practically all the principal cities of the West and some of the Eastern cities had public-street lighting. From the records of the British Parliament it is found that though streets in England were lighted during the reign of Henry VIII, highway robbery was committed with impunity, and such have been the ravages of these gentlemen that Henry VIII ordered, "Hand up the thieves and let honest men stay indoors," and during his reign no less than 7200 persons were hanged. Legislation was put in force to direct that every honest citizen should put up a lantern on his door front to help the public illumination—an order which was hardly carried out by the citizens of the time.

Coming again to the question of domestic and public illumination, it is worthwhile to remember that great impetus to gas lighting was due to the discovery of the Bunsen burner. In the year 1866 Auer von Welshbach, while a student at Bunsen's laboratory at Heidelberg, discovered that the ash formed by burning a cotton fabric which was saturated in a solution of erbium salts, after burning out the organic matter, would take the skeleton shape of the original fabric and would adhere to form a mesh of considerable strength. This finely-divided ash fabric, when suspended in the flame of a Bunsen burner, became intensely luminous. The earliest mantles were composed of a mixture of lanthanun and zirconium oxides; the present-day mantles are, however, impregnated with thorium and cerium nitrates—(thoria 99 p.c., ceria 1 p.c.). We shall soon see how this important discovery of Welshbach served to prolong the life of gas lighting in our modern thoroughfares.

Coming of Electricity

But the modern illuminating agent is neither the age-old oil and wax nor the coal gas, but the energy which introduced a new era in the world's history, namely, the electrical energy. It might be stated that illumination, as it is now understood, is practically tending to be entirely electrical. Near about the latter part of the last century when mechanical inventions and mechanical devices were more and more introduced in the United States of America the electric arc for public illumination purpose was adopted in several cities, though the history of the electric arc dates back to the year 1800 when Davy first lighted his electric arc in his laboratory and though Avenue de l'Opera in Paris in 1815 was lighted up by Jablochkoff candle with the help of eight-hundred Daniell cells. The progressive Americans really took the lead in public illumination by introducing the arc light in their streets. The intense luminosity and the glare of the arc were too strong to be of practical utility in domestic lighting. Edison thought to divide the light. In his attempt to subdivide the light his inventive mind looked into the properties of various materials and finally selected carbon filament enclosed in a vacuum glass globe as a first incandescent electric lamp. It is rather interesting to note how he tried to find out a vegetable fibre to form the material for his filament and how bamboo fibre was finally selected. Just as Edison was endeavouring to design the electric incandescent lamp in

America, so did Swan in England. In the year 1879 both of them succeeded in inventing the electric lamp. It was, however, soon discovered that the efficiency of such lamps deteriorated rapidly with use. The filament gradually became thin and the carbon particles were ejected out from the filaments and stuck to the surface inside the lamps and obstructed the passage of light. The search of substances of high melting point capable of withstanding high heat and at the same time emitting strong light became a problem. Near about the nineties Nernst discovered that certain oxides of rare earth could be pasted round a fine platinum wire which, when heated, gave out an intense glow even if exposed to the ordinary atmosphere, and the Nernst filament lamp became another electric lamp. Its use, however, has been restricted and it requires careful handling to keep the rare earth in position.

Petroleum Lamps

At this stage it is worthwhile to have a little digression. It is well known that during the eighties the vast oil-fields of the U. S. A. were discovered and the crude oil thus secured has been an element of great utility in the march of civilization. The common kerosene has been one of its child and in the early nineties lamps of various designs were introduced all over the world and this earth-oil derivative, kerosene, gradually supplanted the age-old vegetable oils for domestic illumination. Though now the principal cities of the world have been securing electrical energy, the distant rural homes all over the world are yet devoid of this powerful agency. The kerosene has been the principal illuminant of the rural homes of East and West. The various types of lanterns and lamps have undergone remarkable changes within the last quarter of a century, and one can state with impunity that the present enclosed hurricane-lamp has been a friend of the rich and poor alike in all the rural tracts. The lamp in its present form was introduced by Dietz in New York. Quite recently lamps of similar design claimed to be of higher efficiency have also been put into the market by Nier. For indoor purposes the wick in oil lamps was of poor luminosity, but recently their illuminating power has been rendered more efficient by the introduction of compressed air into the lamp containing kerosene. The newer types of lamps use rare earth mantles and the dazzling white light emitted by such lamps is far superior to any other common illuminant. Another derivative of this earth oil is the petrol, the common motor fuel which has enabled man to conquer the air. Petrol is used in specially designed lamps and its gaseous non-luminous flame imparts sufficient heat to the mantles forming a dazzling white-light lamp.

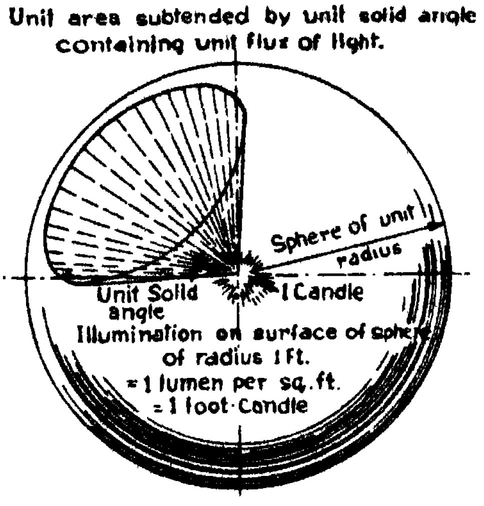
In the latter part of the last century as electric lamps were getting gradually more and more prominent it became the serious rival to the gas lighting which was nearly about a century old. Investigations to improve the efficiency of low-pressure gas lamps (3″ water pressure) led to the use of higher pressures to secure not only higher heating for the mantles but also a better and longer surface for illumination. The gas is further pre-heated to increase the temperature of the flame. But in spite of these improvements of the gas lamps the present tendency is to adopt more and more the electrical energy for illumination purposes. The ease of lighting the lamp quickly, the absence of fumes and other products of combustion, have naturally led towards adoption of electric lamps.

Measurement of Illumination

It would be now worthwhile to consider the fact that when every household used its oil lamps or its wax candles the adoption of a standard for illumination purposes was not of much consideration. When, however, public bodies and corporation took up the supply of gas and electric energy as illuminants for household and public purposes the question of standardization naturally arose. It is rather curious to note that though the British people were the pioneer in this line still by the Act of Parliament they stuck to the old candles as their standard. Their candle was of supermacetti wax weighing six to the pound, burning 120 grains per hour. The wax was never of a uniform composition and so much was the wick affected by the draughts that such a standard was soon found to be unreliable for scientific purposes. The French, on the other hand, adopted a special type of lamp introduced by Carcel with definite specification for its size and wick, burning colza oil (our mustard oil). The luminosity of the lamp was fixed by the size of the flame and the weight of the oil burnt is ascertained by putting the lamp on one pan of a balance. The Germans adopted as their unit the lamp suggested by Hefner which burns pure amyl acetate and gives a flame 40 mm. in light after ten minutes of burning. The reproducibility of this lamp and the purity of its working substance undoubtedly led to its adoption in central Europe as a standard. But the lamp suffered from the defect that its colour is somewhat reddish and it is affected by humidity and carbon-dioxide content of the atmosphere. Meanwhile Sir Vernon Harcourt in England suggested the standard lamp in which pentane is the working fluid and the nozzle is of a refractory material. The standard pentane lamp is of ten-candle power and is now practically adopted as standard all over the world, specially among the English-speaking people. The German Hefner lamp is about 0.9 international candle, and these three units now have been officialized by the International Illumination Commission.

Regarding the measurement of illumination, the International Commission of 1931 has adopted definite nomenclature for the light as the illumination. The determination of this nomenclature is based on the following considerations :-

An ideal candle has been supposed to be capable of emitting light equally in all directions and the light it emits in a unit solid angle is defined to be one Lumen. Thus if we describe a sphere of 1 cm. radius round a point the surface of this sphere has an area of 4π square centimeters and one square centimeter area on its surface is said to subtend unit angle at its centre (Fig. I). Thus we get the concept of "Lumen". An international candle gives out 4π Lumens. Now a lumen striking on a surface 1 sq. ft. area at a distance of 1 ft. from a radiating point produces an illumination "of 1 ft. candle", whereas, if 1 meter be the distance, then on an area 1 sq. meter the illumination is 1 "Lux." Since the ratio of a foot to a meter is little more than three times and since propagation of lights follows the inverse square law, 10 Lux becomes equal to 1 ft. candle. Thus we can understand the usual nomenclature now used in illumination practice.


Unit area subtended by unit solid angle containing unit flux of light.
Sphere of unit radius
Unit Solid angle
1 Candle
Illumination on surface of sphere of radius 1 ft.
= 1 lumen per sq. ft.
= 1 foot-Candle

THE UNIT OF FLUX

Fig. I

We have now to deal with the actual methods of measurements introduced in standardizing practice. We know that the eye is a bad judge of brightness but it can fairly discriminate between two adjacent surfaces whether they are equally lighted or not. The subjective photometry is now well known and the different types of photometers so far used, from the grease spot photometer of Bunsen to that of Lummer Brodhun contrast type now universally adopted, are used in all standard laboratories of the world. It may here be pointed out that the visual photometry is really a physiological function of the eye and recently attempts have been made to substitute the human eye by the electro-optical eye of a photo-electric cell. This also suffers from the peculiar characteristics of the cell in question and the modification of its properties with continual use.

There is another factor worth considering that though the ideal candle has been supposed to be emitting light equally well in all directions this can hardly be realized in practice. The lamp evidently has different luminosity in different directions. In the ordinary candles and all oil-burning lamps it does not illuminate points lying vertically below it.

The inverted gas mantle as well as the inverted incandescent electric bulb also has no light to all points lying directly above it. So it is natural to ascertain some mean value for the illuminating power or the luminosity of any lamp. This value is technically known as *Mean Spherical Candle Power* in Lumens. The actual derivation of this value with the help of a standard photometer is a question of a little mathematical calculation. But for rapid estimations of this value special photometers have been evolved. The principle of such photometers depends on the fact that when any lamp is enclosed on all sides by a spherical hollow box the light emitted by it would after a number of internal scattering from any white matt surface will give out its mean value in any direction. But in that direction the direct light of the lamps should be obstructed. The area of obstruction to the area of the enclosed matt surface should never be less than 1/15th ratio. These photometers are known as sphere photometers or cube photometers according to the shape of the enclosure.

So far we have dealt very roughly with the devices now adopted for measurement of luminosity. For the measurement of the illumination the simple law that illumination is dependent upon the direction in which light is falling on a surface is well known. This is known as the cosine law of Lambert. Now direct comparison with a standard source with the light falling on any surface naturally would give results as one desires either in Lux or in foot candles. Quite recently another interesting property of a cell composed of copper oxide and copper has been discovered. Such a composite cell behaves as an electric cell whose voltage is measured in terms of the light that illuminates it. These photo-voltaic cells are coming more and more into general use for technical purposes of illumination measurement.

To be continued.

Electron Diffraction

Sukhendu Chaudhuri

TOWARDS the close of the nineteenth century it was definitely established that light consists of electromagnetic waves of varying length, and different kinds of light differ only in their wavelength. Its triumph over the old corpuscular theory was thought to be final and complete, particularly after the brilliant experiments of Hertz in 1887 which demonstrated, beyond doubt, the fundamental soundness of Maxwell's electromagnetic theory of light. But this strong foundation of the theory of light was shaken to the root by the phenomenon of what is called the photo-electric emission, that is, the emission of electrons from metal surfaces when light of sufficiently short wavelength is incident upon them. In order to explain the photo-electric phenomenon Einstein suggested that light consisted of units of energy, or photon, which behaved practically like particles. All the photons in a given kind of light are the same, the stronger the light the more numerous they are. The energy of each photon is the frequency of light multiplied by the quantity *h* which is a constant of the quantum theory of Planck.

Now the photon theory of light is all very well for the explanation of photo-electric effect, but to explain the phenomenon of diffraction of light we have to take recourse to the wave theory of light. Thus it appears that light sometimes behaves like waves and sometimes like particles.

Again it is a fact that, when excited, atoms of any element can be made to emit light and each element emits its own characteristic radiations, characterized by definite frequencies. One and only one theory was found capable of explaining the wavelengths of their emitted radiation even in general terms. This was the theory due to Niels Bohr who had to assume a behaviour of the electrons, which is quite contrary to ordinary dynamics and curiously enough, the same quantity *h* came in. The real trouble was that in some phenomena the electrons followed old laws, while in others again, a new type of mechanics was required which is quite distinct from Newtonian mechanics. Sometimes even the two sets of laws had to be used in the same calculation. In the words of G. P. Thomson we may say that "the position of a physicist investigating an atom was rather like that of a man trying to make sense of an account of a game which started as golf and suddenly, for no apparent reason, turned into tennis and then back to golf again. Worse still, as time went on it became clear that the electrons did not play fair even at the game they had for the moment chosen". Thus whenever we try to go deeper into the atoms we are puzzled to see the behaviour of the electetrons composing them sometimes appearing in one form and then in another different from the first as if playing hide and seek with the observer, avoiding detection. Strangely enough, the same quantity *h* is always attached to the interpretation of the behaviour of electrons from the standpoint of new mechanics.

From this we can safely argue that the phenomenon is clearly connected with the photo-electric paradox. De Broglie was the first to put forward an explanation which can successfully solve these difficulties. His theory is a highly mathematical one based on the theory of Relativity. We shall not deal here with the theory of de Broglie but we shall accept only the results of his theory. His conclusion was that any moving particles would be accompanied by a group of waves whose velocity and wavelength are governed by the speed and mass of the particles. He postulated that this group of waves, like pilots, controlled the motion of the particles. These are what are known as de Broglie waves.

According to de Broglie, if m_0 is the mass of the particle for slow speed and v the velocity, the wavelength λ of the the associated wave is given by

$$\lambda = \frac{h\sqrt{1 - \frac{v^2}{c^2}}}{m_0 v} \tag{1}$$

where h is the well-known Planck constant whose value is 6.55×10^{-27} erg secs. and c refers to the velocity of light in vacuo and equals 3×10^{10} cm/sec. approximately. If v can be neglected compared to c, the above equation reduces more simply to

$$\lambda = \frac{h}{m_0 v} \tag{2}$$

The wave velocity V is given by

$$V = \frac{c^2}{v} \tag{3}$$

whereas the group velocity V becomes equal to the speed of the particle.

From equation (1) we can at once find out the wavelength corresponding to a particle of known mass and known velocity. In fact this has been calculated in the case of an electron. For electrons of 25,000 volts energy, the wavelength λ comes out to be $0{\cdot}75 \times 10^{-9}$ cm. As we know this is of the order of hard X-rays, we can infer that waves associated with such electrons should behave in many respects like hard X-rays.

It is needless to say that the theory of de Broglie can explain most simply and successfully the dual nature of waves and particles. The photo-electric paradox now finds an easy explanation from the theory of these waves. For we may argue that a free electron, such as a cathode-ray corpuscle, ought to be guided by waves and consequently should show diffraction effect. This idea can be subjected to experimental test, and indeed successful experiments have been carried out to detect the association of waves with free electrons by Davisson and Germer, G. P. Thomson, and others. We have already seen that the wavelength of the free electron of manageable energy is of the same order as that of X-rays. This fact was utilized in detecting the wave nature of the electrons exactly in the same way as Debye and Scherrer did in the case of X-rays.

It will not be out of place to discuss here the nature of the medium which transmits the electron waves. This question has been tried to be answered by many theoretical physicists, but without much success. If we treat them as ordinary ether-vibrations a serious difficulty arises. All the ether-vibrations differ only in wavelength. If the wavelength is given, the kind of light is settled once for all. The electron waves have varying wavelengths depending on the energy of the electrons but they usually fall in a region which is already occupied by X-rays. But they are certainly not the same as X-rays. We may, however, get rid of this difficulty when we postulate the existence of some medium other than ether (we may call it subether) as the vehicle for electron waves. This is not, after all, an attractive idea to have two ethers filling the same space. Then the waves of protons—if they exist - would demand a third medium for their propagation. Space is thus becoming overcrowded. Other suggestions are to regard the electron waves as a kind of mathematical abstraction, a sort of ghost-waves. The whole question thus seems to be yet far from solution.

We shall now return to the experimental evidence of the presence of electron waves. Davisson and Germer used a beam of homogeneous electrons of energy varying from 65 to 600 volts in their different sets of experiments. It was allowed to fall on a crystal surface of nickel. The scattered electrons are collected in a Faraday cylinder suitably oriented.

If we now substitute the numerical values of h and m in the more simplified formula (2),

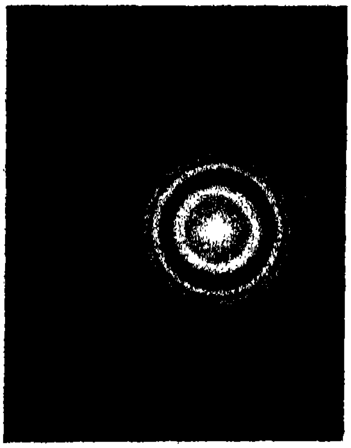
that is, $$\lambda = \frac{h}{m_0 v}$$

and write $$\tfrac{1}{2} m_0 v^2 = \frac{eP}{300},$$ where

P is the potential drop in volts equivalent to the energy of the electron, and e the electronic charge we get

$$\lambda = \sqrt{\frac{150}{P}} \times 10^{-8} \text{ cm}, \tag{4}$$

Davisson and Germer's method is to plot λ or rather $\sqrt{\frac{150}{P}}$ against $\sin\varphi$, following Bragg's well-known law of reflection $n\lambda = d\sin\varphi$ where n, d, and φ have their usual significance. For each value of n he draws the straight line $d\sin\varphi\ n = \lambda$. The observed beam should all lie on one of these straight lines if they obey the plain law. They found that this requirement was satisfied most satisfactorily. This result is a strong confirmation of the existence of de Broglie waves.

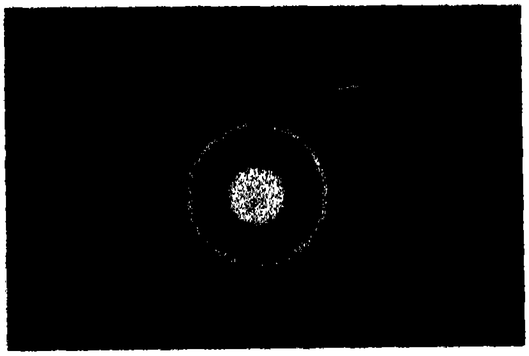


Normal zinc oxide.

Next we turn to the diffraction of electrons when transmitted through thin films. The first experiment in this line was carried out by A. Reid. A beam of cathode rays was passed through a fine tube and then deflected by an electrostatic field. This deflected beam passed through a hole ·25 mm in diameter immediately behind which was mounted a thin film of celluloid. After passing through the film the beam traversed a distance of 20 cm and then struck a photographic plate placed normally to the beam. The pattern consisted of an intense central spot surrounded by one or more fainter rings. The wavelength required was of the right order to fit de Broglie formula, and the angular diameter of any ring was approximately inversely proportional to square root of the voltage. The thickness of the films used was of the order of 3 to 5×10^{-6} cm as estimated by interference measurements.

No exact comparison with the theory is possible by this experiment as the structure of celluloid is unknown. G. P. Thomson then tried to diffract electrons by transmission through thin films such as those of aluminium, gold, silver, tin, platinum, etc. The exposures varied from a few seconds up to a few minutes depending on the intensity and voltage of the cathode rays used. In all cases, the patterns show a series of concentric rings round the central spot which is formed by the undeflected beam (See figs) In every case examined, the agreement between theory and experiment is entirely satisfactory and we are led to suppose that the electrons form the diffraction patterns just similar to those which would be produced by waves of $\lambda = h/m_0v$. In addition to these thin films, experiments were carried out using spluttered films of gold, silver, lead, iron, nickel, etc.

Dr. E. Rupp performed a series of experiments on the diffraction of slow electrons of 150-300 volts energy, passing through thin metal films. Though the rings were diffuse and very faint, the relative sizes of the rings agreed with the crystal structure to about 5 per cent.

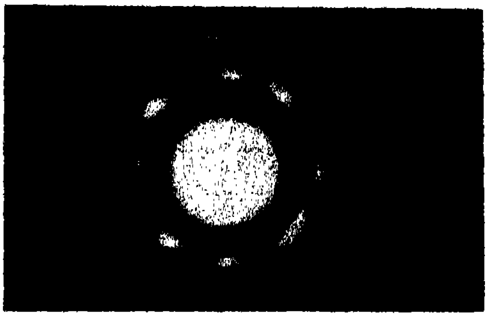


Gold

Using very thin films of mica, Kikuchi has obtained some very beautiful and remarkable results. The voltages used varies from 10 kilovolts to 85 kilovolts. Different types of diffraction patterns were found, depending on the thickness of the mica film. With thinnest films (thickness of the order of 10^{-5} cm) the pattern showed a netlike structure arranged in three sets of parallel lines at 60° to each other. With films thick enough to show interference colours the pattern consists of spots resem-

bling Laue spots accompanied by black and white lines. The analysis of the pattern showed excellent agreement with the known structureof mica.

Nishikawa and Kikuchi have shown that even an insulator like calcite can be made to give diffraction patterns by reflection of electrons. The patterns took the form of black and white lines from which the spacings of the crystal can be calculated and the agreement was found to be good. Emslie has observed these lines with calcite but not with galena which is a conductor.



Aluminium

In a later investigation Rupp has succeeded in demonstrating the reflection of electrons by a ruled grating at very oblique incidence, thus showing the similarity of electrons and X-rays. This type of experiment has also been carried out by Worsnop.

Application of Electron Diffraction to the study of Surface Phenomena

The interference phenomena occurring in the reflection of slow electrons open new possibilities for the examination of surface structure. They have two advantages over X-rays in this respect. They penetrate less deeply and the interaction between the electrons and the atoms in the substance under investigation is more intimate that that occurring in case of X-ray reflection. In the case of electrons, only the first ten or twenty layers are effective while with X-rays thousands of atomic planes are involved. The electronic interaction with the atoms shows itself by the occurrence of a refractive index for slow electrons. In Davisson and Germer's experiment there occurred certain characteristics in the diffraction patterns which were attributed to several layers of gas atoms on the crystal surface. The effect of allowing gas to come in contact with nickel surface in the above experiment was to diminish the intensity of diffraction maxima and this was due to layers of gas molecules covering the surface. In addition to the intensity change two other types of diffraction pattern were observed. These appeared after heating a crystal and allowing it to cool. They were of short duration and were noticeable a short time after the heating process. Germer's conclusion was that the gas atoms form a single layer arranged like the atoms of the crystal but with a double separation at a depth of 3Å below the first layer of nickel atoms. The fast electrons are not influenced by thin layers of gas normally present on surfaces in vacuum or possibly that they temporarily remove the layers by bombardment. The targets used are single crystals or a mass of small crystals. In addition to regular pattern there is always a background of diffuse scattering probably mostly due to electrons which have lost energy by inelastic collision. In many cases the background is all that appears because the surface layer is really amorphous or, if crystalline, is constructed in such a way that diffraction at small angles is impossible.

C. A. Murison has examined the diffraction pattern formed by transmission of electrons through thin films of vaseline, paraffin wax, picein, tallow, lard, Everet's thick and thin tap greases, thermostat oil, $C_{33}H_{46}$ and $C_{22}H_{82}$. The patterns indicate orientation of the molecules normal to the surface of the film and the experiment shows that this orientation is present both at the vacuum grease and backing-grease interfaces. Substances which gives this pattern are likely to act well as lubricants.

Many experiments have been attempted to see whether polished metal surfaces show ring patterns by reflection of electrons. Pollycrystalline surface layers give ring patterns. In this connection it must be remembered that the angle of incidence is only of the order of 1°. In the first place, it is obviously necessary that the surface should be crystalline and this is probably the reason why polished metal surfaces have not shown diffraction rings. The process of polishing presumably produces a layer of amorphous metal and the electrons are irregularly diffused without forming any pattern. A surface of aluminium etched with caustic potash also failed to give a pattern. A layer of gold spluttered on quartz gives very good rings. The surface is matt and probably consists of a series of irregular lumps small enough for the electrons to penetrate them. A polished lead surface heated to near the melting point showed rings which, though rather faint, were easily measurable and corresponded to the structure assigned to PbO. Germer has also shown that fast electrons scattered from polished metal surfaces do not form diffraction rings. A strong Debye-Scherrer pattern is produced, however, by electrons scattered from a surface which has been mechanically roughened in such a manner that electrons are able to pass directly through projecting irregularities. Small ridges extending from wires which have been drawn through an imperfect die also give rise to a diffraction pattern. These experiments indicate (1) that there is no considerable layer of amorphous material (Beilby layer) on a polished metal surface, and (2) that Debye-Scherrer patterns are formed only by transmitted electrons.

H. R. Nelson has examined the case of reflection of electrons (energy 20 to 50 KV) at very grazing incidence from the film of vaseline, paraffin, and tap-greases. The diffraction pattern consists of rows of spots similar to an X-ray single crystal rotation picture. Observed reflections are in good agreement with the structure of normal hydrocarbon crystals. This shows that the films are largely crystalline with the long axes of individual crystal perpendicular to the plane of the film.

Diffraction by Liquid Substances

Coming to the case of diffraction by liquids L. R. Maxwell has obtained electric interference by transmission of electrons through liquid films of phytol ($C_{20}H_{39}OH$) Nujol and two different grades of cenco vacuum-pump-oil. The patterns obtained for these four liquids are practically the same and characterized by three complete diffraction rings. The rings indicate the spacings to be of such values as are obtained by G. W. Stewart for X-ray diffraction in liquid pentadecane and tetradecane. The problem of interpreting the results by a group theory such as proposed by Stewart is the same for electrons as for X-rays.

Electron Diffraction by Gases and their Molecular Structure

Mark and Wierl were the first investigators to work in this line, and the vapour used was that of carbon tetrachloride. The vapour was contained in a glass-bulb with a controlling tap, and the outlet tube was drawn down so that the vapour molecules emerged opposite the end of the defining slit for the electron beam. In order to confine the vapour to as short a path as possible, a cooled surface was provided opposite the jet and on this the "spent" vapour condensed.

The distance between the atoms of the bromine molecule as determined by Wierl is very close to Mecke's bandspectrum measurement of 2.26 A. U. It is thought that CO_2 and CS_2 are linear molecules and this agrees with X-ray results. Evidence on the dipole-moment of SO_2 ($1.61-1.76 \times 10^{-18}$ e. s. u.) suggests that this molecule may be triangular but the observations are not conclusive. The experimental results on the tetrahedral molecules are in good agreement with the assumption of the regular model. It is interesting to note that the distance between the central atom and an outer one is in each case almost exactly the same as the ones deduced by Goldschmidt and Pauling from crystal structure work on the basis of ionic radius. It had always been thought that the tetrahedral binding was homopolar rather than heteropolar.

Wierl outlines five important problems in organic chemistry which, he thinks, it may be possible to solve by means of electron diffraction experiments:

(1) Whether the distance between carbon atoms in aliphatic compounds is distinguishable from the same distance in aromatic compounds.

(2) Is a distinction between plane and puckered cyclic compounds possible ?

(3) Can anything be discovered concerning free rotation in aliphatic chains ?

(4) Are the structures of isomers of unsaturated carbon compounds what the descriptive formulae suggest ?

(5) Is rotation in saturated hydrocarbons absolutely free ?

To solve the problems (1) and (2), benzene, cyclohexane, and cyclopentane were studied by Wierl. Definite evidence in favour of a plane structure for benzene and cyclopentane was obtained and the indications are that the cyclohexane molecule is puckered. Questions of isomerism and free rotation in compounds of the type of $C_2 H_2 Cl_2$ and $C_2 H_4 Cl_2$ have also been discussed by Wierl. The most interesting and satisfying feature of the results obtained by Wierl is the general agreement between the values deduced from electron diffraction for the carbon-carbon distance (single, double, and triple bond conditions) with the values deduced following the methods of X-ray crystallography and infra-red spectroscopy.

Finally, mention must be made of the works carried out by H. de Laszlo on six benzene derivatives in the vapour phase. They are hexa-chlor, hexa-brom, benzene, symmetrical tribrom, tri-iodo benzene, *p*-dibrom and di-iodo benzene. The results agree well with the theoretical scattering curve based on a model where benzene is a regular flat hexagonal ring with carbon-carbon distance 1.41 Å.

The halogen-carbon distances were found to be

$$\text{C-Cl} = 1.69\ \text{Å} \pm 0.01\ \text{Å}$$
$$\text{C-Br} = 1.88\ \text{Å} \pm 0.01\ \text{Å}$$
$$\text{C-I} = 2.05\ \text{Å} \pm 0.01\ \text{Å}$$

These distances appear to remain constant and to be independent of the number of similar atoms substituted at the same time in the benzene ring, and all the atoms lie in the same plane as the benzene ring.

These carbon-halogen distances are always less than those generally accepted for aliphatic compounds, the discrepancy being of the order of 0.06 Å.

Polarization of Electrons

So far we have discussed such experiments in which the electrons behave as waves, the wavelength given by the de Broglie formula. Necessarily the question arises that if these de Broglie waves suffer interference, reflection, refraction, and the allied phenomena, they should also show what is called polarization. We shall now deal with what success has been achieved as regards the answer of the above question.

In order to explain optical spectra, it is necessary to assume that an electron has more than 3 degrees of freedom associated with it. It is regarded as a spinning body with magnetic moment $eh/4\pi mc$ and mechanical moment $h/4\pi$. There is nothing in de Broglie-Schrödinger wave-mechanics corresponding to this and the theory is thus unable to account for effect like fine structure of hydrogen spectra or to predict correctly the results of Stern-Gerlach experiments. In Dirac's relativistic wave theory this defect is removed and the electrons appear with directional properties resembling those of spinning model. Darwin shows that a freely moving electron has a magnetic moment $eh/4\pi mc$ for speed small compared with that of light. The direction of the magnetic axis has no necessary relation to direction of the motion of electron and need not be in the wave front nor can it be determined by measuring the force the electron exerts on magnetometer, because of the inherent uncertainty in the position and velocity of the electron. Mott concluded that nuclear scattering ought to produce an appreciable asymmetry of the scattered beam if certain conditions are fulfilled. This asymmetry can be shown by a second scattering under similar conditions. This asymmetry is one of 180° round the axis of the beam and not 90° as in the case of light or X-rays. Several workers have examined the double right-angled scattering of cathode rays by metals in an attempt to test Mott's theory, but no definite conclusion has yet been arrived at. It is seen that there is no polarization of the kind required by Mott's theory within the limits of probable error. Thus one is inclined to surmise that the polarization of a free electron may be among the unobservables.

Presidential Address to the British Association for the Advancement of Science, 1936.

The Impact of Science upon Society

Sir Josiah Stamp
President of the Association.

The reactions of society to science have haunted our presidential addresses with various misgivings for some years past. In his great centenary address General Smuts, answering the question 'What sort of a world picture is science leading to?' declared that one of the great tasks before the human race is to link up science with ethical values and thus to remove grave dangers threatening our future. For rapid scientific advance confronts a stationary ethical development, and science itself must find its most difficult task in closing a gap which threatens disruption of our civilisation, and must become the most effective drive towards ethical values. In the following year a great Engineer spoke as a disillusioned man, who watched the sweeping pageant of discovery and invention in which he used to take unbounded delight, and concluded by deploring the risk of losing that inestimable blessing, the necessity of toil and the joy of craftsmanship, declaring that spiritual betterment was necessary to balance the world. Then came the President of the Royal Society, a supreme Biochemist, on the perils of a leisure made by science for a world unready for it, and the necessity for planning future adjustment in social reconstructions. Followed the Astronomer, deploring man's lack of moral self-control; in knowledge man stands on the shoulders of his predecessor, whereas in moral nature they are on the same ground. The wreck of civilisation is to be avoided by more and not by less science. Lastly, the Geologist gloried in the greatest marvel of millions of centuries of development, the brain of man, with a cost in time and energy that shows us to be far from the end of a mighty purpose, and looking forward confidently to that further advance which alone can justify the design and skill lavished on such a task. So the Geologist pleads then for scientific attention to man's mind. He has the same faith in the permanence of man's mind through the infinite range of years

> 'Which oft hath swept this toiling race of men
> And all its laboured monuments away,'

that is shown at the Grand Canyon, where at the point exposing, in one single view, over a billion and a half years of the world's geological history, a tablet is put to the memory of Stephen Tyng Mather, the founder of the National Park Service, bearing what is surely the most astonishing scientific expression of faith ever so inscribed:

> 'There will *never come an end* to the good that he has done.'

We have been pleading then in turn for ethical values, for spiritual betterment, for right leisure, for moral advance, and for mental development, to co-ordinate change in man himself with every degree of advance in natural science in such a harmony that we may at last call it Progress. This extention of our deeper concern beyond our main concern is not really new, but it has taken a new direction. I find that exactly one hundred years ago there was a full discussion of the moral aspects, a protest that physical science was not indeed, as many alleged, taking up so much of the attention of the public as to arrest its study of the mind, of literature and the arts; and a round declaration that by rescuing scientists from the narrowness of mind which is the consequence of limiting themselves to the details of a single science, the Association was rendering 'the prevailing taste of the time more subservient to mental culture.' A study of these early addresses shows that we are more diffident to-day in displaying the emotions and ideals by which I do not doubt we are all still really moved. But they also show that we are pre-occupied to-day with some of the results of scientific discovery of which they were certainly then only dimly conscious. A part of that field, which ought itself to become scientific, is my theme to-day.

What do we mean by impact? My subject is *not* the influence or effect of science upon society—too vast, varied and indeterminate for such an occasion. We may consider the position of the average man, along a line of change we call 'progress', at the beginning of a certain interval of time and at its end. We might then analyse how much is due to a change in the average man himself, his innate physical and mental powers, and how much to other influences, and particularly to science. We may debate whether the distance covered is great or small by some assumed standard, and whether progress has been rapid. We might ask whether the direction has been right, whether he is happier or better—judged again by some accepted standard. But our concern here is with none of these questions. I ask whether the transition has been difficult and distressing, in painful jerks and uprootings, costly, unwilling, or unjust; or whether it has been easy, natural, and undisturbing. Does society make heavy weather of these changes, or does it, as the policeman would say, 'come quietly'? The attitude of mind of our order may be either that change is an interruption of rest and stability, or that rest and stability are a mere pause in a constant process of change. But these alternatives make all the difference to its accommodating mechanisms. In one case there will be well developed tentacles, grappling irons, anchorages, and all the apparatus of security. In the the other, society will put on casters and roller bearings, cushions, and all the aids to painless transition. The *impact* of science will be surprising and painful in the one case, and smooth and undamaging in the other. Whatever may be the verdict of the past, is society and its institutions now learning that change is to be a continuous function, and that meeting it requires the development of a technique of its own?

Science itself has usually no immediate impact upon institutions, constitutions and philosophies of government and social relations. But its *effects on* people's numbers, location and habits soon have; and the resistance and repugnance shown by these institutions and constitutions to the changed needs may rebound or react through those effects upon scientific enterprise itself and make it more precarious or more difficult. Thus the effect of applications of electricity and transport improvements is clearly to make the original areal extent of city or provincial governments quite inappropriate, and the division of functions and methods of administration archaic. If these resist change unduly they make it more difficult and frictional, and the applications of science less profitable and less readily acceptable. Time makes ancient good uncouth. When two bodies are violent or ungainly in impact, both may be damaged. If the written constitution of the United States, devised for the 'horse and buggy' days, still proves not to be amenable to adjustment for such demands, it will be difficult to overstate the repercussion upon economic developments and the scientfic enterprise that originates them. Let the Supreme Court Decision of unconstitutionality on the Tennessee Valley experiment in large scale applied science to natural problems on a co-ordinated plan bear witness. Such unnecessary resistance may be responsible for much of what has been aptly called 'the frustration of science.' Avoidable friction in the reception given to scientific discovery not only deprives the community of advantages it might otherwise have enjoyed much earlier, or creates a heavy balance of cost on their adoption; it may also discourage applied science itself, making it a less attractive and worthwhile pursuit. In that sense we are considering also the impact of society upon science. This too is not new. The Association had as one of its first objects 'to obtain a more general attention to the objects of Science, and a removal of any disadvantages of a public kind which impede its progress.' The first address ever offered affirmed that the most effectual method of promoting science was the removal of the obstacles opposing its progress, and the President instanced the very serious obstacles in the science of optics due to the regulations relating to the manufacture of glass. To-day perhaps the scientist places more stress upon the failure of governments to encourage, than upon their tendency to discourage. So much then for the *idea* of impact. *Is* the scientist or inventor responsible for impact, and if not, who is?

Elsewhere I have retouched Jeremy Bentham's poignant picture of the inventor of over a century ago, plans and cap in hand, on the doorstep of the rich or influential, waiting for someone to believe in him. From this type of external 'sport' amongst engineers and scientists came much or most industrial innovation, external to the processes of business. To-day, in the older and applied sciences affecting industry the solo scientist is the exception and, with the large research departments of particular businesses and trade research associations, the picture is quite different—the expenditure higher, but the results much more rapid and numerous even if for a time they may be kept secret. Although records of finished work may be available over the civilised world, there is much overlapping of current work, but the price of this as a whole is a far smaller fraction of the total result, if we omit from our consideration the first magnitude discoveries of epoch-making influence. The industrial community is now far more amenable than hitherto to scientific influence, indeed it is often the instigator in the mass of minor advances. The new epoch of concerted industrial research dates really from the end of the great war. During all that time I have held some middle position of responsibility between the research laboratories and institutes on the one hand, and the costing and profit and loss accounts on the other, and my impression is that the proportion of work in which the initiation comes from the business end is steadily increasing. In studies of the periods of scientific and industrial gestation respectively, I have elsewhere defined *scientific gestation* as the time elapsing between the first concept of the idea and its public presentation to society in a form substantially that in which it ultimately finds extensive use without important modification; and *industrial gestation* as the period elapsing from this point to the date when in an economic or industrial sense the innovation is effective. Both periods are difficult to determine exactly in practice, but on a broad view, the period of industrial gestation, with which alone I am here concerned, appears to me certainly to have shortened materially, though possibly at greater social cost. It would obviously be so if industry is actively encouraging research. 'Faraday's discoveries came at the beginning of the great steam era, and for fifty years there would have been no difference in transport even if those discoveries had not been made,' for the telegraph was the only meterial influence upon it, and practical lighting was delayed till 1900.

In nearly every scientific field there is sub-division of labour, and it is rare that the worker who digs out new truth 'at the face,' so to speak, is also responsible for bringing it to the surface for the public use, still less for distributing the new scientific apparatus or ideas broadly, and even less for the profitable exploitation of the whole process. These functions are nearly always distinct, even though they are embraced under the one general popular description: chemist, engineer, etc. But in few cases is it any part of the professional training in the subject itself, to study how new products or processes affect the structure or welfare of society. I have questioned many scientific workers and find them, of course, keenly alive to the positive and direct beneficial effects of their work, but they have rarely any quantitative ideas as to negative, indirect and disturbing consequences. All these discoveries, these scientific infants, duly born and left on the doorstep of society, get taken in and variously cared for, but on no known principle, and with no directions from the progenitors. Nor do the economists usually acknowledge any duty to study this phase, to indicate any series of tests of their value to society, or even of methods and regulation of the optimum rate of introduction of novelty. These things just 'happen' generally under the urge of profit, and of consumers' desire, in free competition, regardless of the worthiness of new desires against old, or of the shifts of production and, therefore, employment, with their social consequences. The economist rightly studies these when they happen, but he is not dogmatic about them not being allowed to happen at all in just that way on account of the social disturbance or degradation of non-economic values which they may involve. It is truly a 'no-man's land' for it is rarely that the functions of government begin until a vested problem exists. Especially in Britain we do not anticipate—'Don't worry,—it may never happen.' Problems with us are usually called 'academic until we are 'going down for the third time.' It is a maxim of political expediency not to look too far ahead, for it is declared that one will always provide for the wrong contingency. The national foresight over wireless was exceptional, and it has to be contrasted with the opportunist treatment of the internal combustion engine. In reply, it can, of course, be urged that no one can foresee just how a scientific idea will develop until it is tried out, rough and tumble, in economic society, and to make anticipatory rules may even hinder its development.

It is rightly stated that the training of the scientist includes no awareness of the social consequences of his work, and the training of the statesman and administrator no perparation for the potentiality of rapid scientific advance and drastic adjustment due to it, no prevision of the technical forces which are shaping the society in which he lives. The crucial impact is nobody's business.

When the research worker lifts his attention from his immediate pursuit and contemplates its hinterland, he has three possible areas of thought. He may dwell upon its practical applications and seek to make them as immediate and realistic as possible; moved by the desire not to be merely academic, he may return to his task, to focus his attention primarily on what is likely to be of practical utility, rather than on what is intellectually intriguing. Or he may think of its ultimate social consequences, and speculate on the shifts in demand, the unemployment, the loss of capital, the ultimate raising of the standard of life that may result—in other words, he may engage in economic prevision and social and political planning for the results of his efforts. Or in the third place, he may listen and watch for hints from other fields of scientific study which may react upon his own, and suggest or solve his problems. I do not attempt to give these priority. Economic and political prevision is the most difficult and precarious, because it needs a technique different from his own, and is not given by the light of nature. Specialist scientists have no particular gifts for understanding the institutional processes of social life and the psychology of multiple and mass decisions. It is a tortuous and baffling art to transmute their exact findings into the wills and lives of unscientific millions. But quite a number engage in the pursuit and have not much greater aptitude as amateur ministers of foresight than statesmen would have in planning research. Fewer are skilled, however, in what should be the most appropriate auxiliary to their work—the synthesising of scientific knowledge. The more penetrating they are in their main pursuits, the less may they absorb through analogy or plain intimation from outside. We constantly hear that the average clinical application lags much farther behind the new resources of diagnosis from the laboratory than circumstances compel. But it may be the other way round. The strongest hint of the presence of a particular factor —a positive element in beri-beri—was given by the clinician to the bio-chemist, who relied entirely on the *absence* of a particular factor, a negative element, no less than fifteen years before the bio-chemist took serious notice, looked for it, and found it. Bacteriology and chemistry await the advance of the bio-chemist before they come effectively to each other's assistance. The cause and prevention of the obstinate degree of maternal mortality are objects pursued *ad hoc*, with hardly a casual glance at the direct appeal of the eugenist to observe the natural consequences of an improvement in female infant mortality two decades earlier.

I do not then pretend to dogmatise as to how far the scientist should become a social reformer. One physicist welcomes the growing sense of social responsibility, among some scientists at least, for the world the labours of their order have so largely created, though he deplores that in this field they are still utterly unscientific. Then another great authority, Sir Henry Dale, declares that it is the scientists' job to develop their science without consideration of the social uses to which their work might be put.

I have long watched the processes by which the scientific specialist 'makes up his mind' in fields of enquiry outside his own. It seems still a matter for investigation whether the development of a specialist's thinking on balance impairs or improves the powers of general thinking compared with what they might otherwise have been. We do not know the kind or degree of truth that may rest in Anatole France's aphorism: 'The worst of science is, stops you thinking.' Perhaps this was more subtly expressed in the simpler words of the darkie mother: 'If you haven't an education, you've jest *got* to use yoh brains.'

My own experience is that when the attempt to deal with social consequences is made, we quickly find ourselves either in the field of larger politics debating the merits of the three prevalent forms of state government, or else performing miracle with fancy currencies and their blue prints reminiscent of the chemical engineer.

But there are some essential features of the impact which must be dealt with under any form of society and government and with any machinery for regulating values. They involve man's abilities, his affections, and his tools, all of which have been brusquely treated in the past, and might be scientifically treated in the future. An industrial civilisation is unthinkable without division and, therefore, specialisation, of labour, and without tools and capital instruments. Then life itself is not much worth living without social ties and the allegiances of place and kin. These three indispensable elements of the good life bring out defensive mechanisms for their protection. No one likes to see a man trained for a special service or specially fitted by natural aptitudes cut off from opportunity to use his powers and reduced to the level of an unskilled biped. No one likes to see the results of abstinence and specially directed labour which is embodied in a great machine or factory rendered impotent long before it has given its life's usefulness. Waste of skill and of capital are alike grave faults by which we should judge and condemn an industrial organisation. And since man does not live by bread alone, if a ruthless industrial organisation continually tears up the family from its roots, transferring it without choice, to new surroundings, destroying the ties of kin, home and social life, of educational and recreational environments, it is far from ideal. Human labour can never be indefinitely fluid and transferable in a society that has a soul above consumption of mere commodities. These three obstructions to change are not final and rigid limitations upon it. Men die, their skill and home associations with them. Plant and equipment wear out. · Their successor presents a natural opportunity in each of the three cases for the introduction of change in position, in aptitude, in purpose or design, without waste or human distress. The length of working life and the durability of meterials mark the natural phase or periodicity of a smoothly changing society—its quanta, so to speak. But the impetus for change or the irritant has no such intervals. It proceeds from various causes: varying harvests, changes in natural forces; changing human desires and fashions; differences in the rate of growth of population in its different parts; the collective psychological errors of optimism and pessimism in business in an individualistic society; variations in gold supplies and credit policies based thereon. All or any of these, without invoking any disturbances from the impact of scientific discovery, would serve to make adjustments necessary outside the natural phases to which I have referred, in a society with parts that are interdependent through division of labour, and localisation of industry, joined by foreign trade and convenient transport. These alone would bring about a changing world with incomplete adaptations, loss of capital, and so-called frictional unemployment. It is easy to exaggerate the adjustment necessary for the addition of invention and science to these causes of change. But with the intensification of scientific effort, and the greater sub-division of industry, the possible dislocation becomes more frequent and the ways of meeting such change of greater public importance. This field of inquiry includes widely diverse questions, e.g., patent laws, invention clearing, obsolescence accountancy and costing regulation, taxation adjustments, local rating pooling, trade union regulations, price controls, technical education, age and other discriminations in unemployment relief, transfer bonuses, pension rights, housing facilities, and more selective direction of financial support of intensive scientific research. In this neutral field the specialist scientist and the politician are both amateurs. It is to be covered by each extending his studies, and by specialists who treat impact and change as an area of scientific study.

I do not propose to go over all the ground, so old, so constantly renewed, as to the effect of machinery upon employment. It is known as an historical induction that in the long run, it makes more employment than it destroys, in providing work in making the machinery, in reducing price so that far greater quantities of the commodity concerned may be consumed, and in enabling purchasing power to be diverted to increase other productions. It has even facilitated the creation of a larger population, which in turn has provided the new markets to work off the additional potentiality of the machinery. It does all this in 'the long run,' but man has to live in the short run, and at any given moment there may be such an aggregation of unadjusted 'short runs' as to amount to a real social hardship. Moreover, it comes in this generation to a people made self-conscious by statistical data repeated widespread at frequent intervals, and to a people socially much more sensitive to all individual hardship and vicissitude which is brought about by communal advance.

There are two important aspects of the change induced by science which are insufficiently realised, and which makes a profound difference to the direction of thought and inquiry. The first I will call the 'balance of innovation' and the second the 'safety valve' of population.

The changes brought by science in economic life may be broadly classified as the 'work creators' and the 'work savers.' The latter save time, work, and money by enabling the existing supply of particular commodities to be produced more easily, and therefore at lower cost, and finally at lower prices. People can spend as much money as before upon them and get larger quantities or they can continue to buy their existing requirements at a lower cost. In this second event they 'save money' and their purchasing power is released for other purposes. By a parallel process, producing or labouring power is released through unemployment. The released working force and released purchasing power can come together again in an *increased* demand for other products which, to this extent, have not been hitherto within effective demand. The supply of this increase may go part or all of the way to absorb the displaced labour. But this process takes time, and the labour displaced is not at once of the right kind nor in the right place. More important, however, is the invention of quite new objects of public demand, which may be desired in addition to the supply of old ones. This brings together released labour and released purchasing power in the most decisive way. The most orderly and least disturbing phases of progress will be found when these two types of innovation are reasonably balanced. Of course, few new objects of purchasing ambition are entirely additive; most of them displace some other existing supplies. Artificial silk displaces some cotton consumption, radio may displace some types of musical instruments. Recently the German production of pianos and guitars has been at a very low percentage of capacity, and part of this has been made good by the demand for radio sets. The dislocations caused by labour-saving machinery can most easily be made good by a due *balance* of new labour creating commodities.

A natural increase of population is the best shock absorber that the community can possess, especially if accompanied by an extension of territory such as the United States enjoyed in the constant westward movement of the frontier in the nineteenth century, or Britain in the period of overseas emigration. A moment's reflection will show why this is the case. Assume that 1,000,000 units of a commodity are made by 100,000 men, and that there is an increase of population of 2 per cent per annum, so that in five years 1,100,000 units will be consumed and employ 110,000 men. Now assume the introduction of a new invention which enables 1,100, 000 units to be made by 100,000 men. There will be no displacement of existing labour, but only a redirection of new and potential labour from that industry to other fields. Again, a considerable reduction in demand *per head* can be sustained without dislocation, if the actual aggregate of production demanded is maintained by increasing numbers. The affected industry can remain static and need not become derelict. New entrants to industry will be directed to those points where purchasing power, released through labour-saving devices, is creating new opportunity with new products. New capital is also naturally directed into the new channels, instead of into additions to the old industry.

Now the problem before all western industrial countries is the fact that their populations are shortly becoming stationary (and then will begin to decline noticeably) and this safety valve of increasing population will no longer be available. Every transfer of *per capita* purchasing power to new directions must then be a definite deduction from the old directions, no longer made good by the steady increase in the numbers demanding less per head from those old sources. The impact of science upon a stationary population is likely, *ceteris paribus*, to be much more severely felt than upon a growing population, because the changes of direction cannot be absorbed by the newly directed workers. Of course, the effects of a static population can be mitigated if the *per capita* income is increasing, because a new direction of demand can be satisfied out of the additional purchasing power without disturbing the original directions of demand provided by the original purchasing power. But the change from a growing to a static or declining population is only one type of difficulty. While the aggregate is altering but slowly, the parts may be changing rapidly. Thus, in this country 40.4 millions in 1937 becomes 40.6 in 1942, 40 in 1947, 39.8 millions in 1952, 38.9 in 1957 and 37.5 in 1962. But the children aged 16—which I take because of its influence on schools, teaching and industrial entry —have been estimated, taking those in 1937 as 100, to be 85 in 1942, 73 in 1952 and 62 in 1962. A fall of this magnitude means that industries and institutions dependent upon the present numbers must not be merely static but actually regressive. On the other hand the old people from 65 to 74 will increase in this ratio—100, 113, 127, and 138. These problems of static populations at home are accentuated by the possibility of a similar tendency abroad, and need thought in advance. The Australian farmer is more affected by the British conditions of population than by his own.

We have thus the first difficulty, that of a static total demand, the second, that the safety valve of new industrial entrants is becoming smaller, but a third difficulty comes from the present tendency of that class. A stationary elderly population must be very inflexible to change, but a stream of new young life, even if it is to be smaller, would give the opportunity for just that change of direction, in training and mobility, which society needs. But unfortunately, in practice this does not now seem to be very adaptable. For we learn from certain Unemployment Insurance areas that while the older people will willingly take jobs at wages a few shillings in excess of the unemployment relief, the younger men are more difficult. For every one that will accept training under good conditions to suit them for eligible work, ten may refuse, and the number who will not go any distance to take work at good wages is also in excess of those who do. Attachment to place for older people is understandable, and has been accentuated by housing difficulties—one learns of miners unemployed in a village where the prospects of the pit reopening are negligible, while at the same time, only twenty miles away new miners are being created by attraction from agriculture to more extended workings in their area. . The very social machinery which is set up to facilitate change or to soften dislocation, aggravates the evil. The first two difficulties are unalterable. *This third difficulty is a subject for scientific examination.*

So much for the effect of change of any kind upon employment. Now let us narrow this to scientific changes. At any given moment the impact of science is always causing some unemployment, but at that same time the constructive additional employment following upon past expired impacts is being enjoyed. But it is easy to exaggerate the amount of the balance of net technological unemployment. For industrial disequilibrium arises in many ways, having nothing whatever to do with science. Changes of fashion, exhaustion of resources, differential growth in population, changing customs and tariffs, the psychological booms and depressions of trade through monetary and other causes, all disturb equilibrium, and, therefore, contract and expand employment in particular places. Our analytical knowledge of unemployment is bringing home the fact that, like capital accumulation, it is the result of many forces. A recent official report indicated that a quite unexpected amount or percentage of unemployment would be present even in boom times. We know already that there may be a shortage of required labour in a district where there is an 8 or 10 per cent figure of unemployment. So, in this country there may well be a million unemployed in what we should call good times—it is part of the price we pay for the high standard of life secured by those who retain employment. For a level of real wage may be high enough to prevent every one being employable at that wage—though that is by no means the whole economic story of unemployment. Of this number probably 200,000 would be practically unemployable on any ordinary basis—the 'hard core' as it is called. Perhaps seven or eight hundred thousand from the perpetual body, changing incessantly as to its unit composition, and consisting of workers undergoing transition from job to job, from place to place, from industry to industry, with seasonal occupations—the elements of 'frictional' unemployment through different causes. Out of this number, I should hazard that not more than 250,000 would be unemployed through the particular disturbing element of net scientific innovation. This is the maximum charge that should be laid at the door of science, except in special times, such as after a war, when the ordinary application of new scientific ideas day by day has been delayed, and all the postponed changes tend to come with a rush. At any given moment, of course, the technological unemployment that could be computed from the potentiality of new processes over displaced ones, appears to be much greater. But such figures are *gross*, and from them must be deducted all recent employment in producing new things or larger production of old things, due to science. If we are presenting science with part of the responsible account of frictional unemployment at any moment, it will be the total technological reduction due to new processes and displacement due to altered directions of demand, less the total new employment created by new objects of demand. This has to be remembered when we are being frightened by the new machine that does with one man what formerly engaged ten. Perhaps birth control for people demands ultimately birth control for their impedimenta.

The rate of introduction of new methods and the consequent impact upon employment may depend upon the size and character of the business unit. If all the producing plants for a particular market are under one control, or under a co-ordinated arrangement, the *rate of introduction of a new labour-saving device will* be governed by a simple consideration. It can be introduced with each renewal programme for each replacement of an obsolete unit, and therefore without waste of capital through premature obsolescence. But this applies only to small advantages. If the advantages are large, the difference in working costs for a given production between the old and the new types may be so considerable that it will meet not only all charges for the new capital, but also amortize the wasted life of the assets displaced before they are worn out. In neither case then is there any waste of capital, and the absorption of the new idea is orderly in time. But it is quite otherwise if the units are in different ownerships. Excess capacity can quickly result from new ideas. A new ship or hotel or vehicle with the latest attractions of scientific invention, quite marginal in their character, may obtain the bulk of the custom, and render half empty and, therefore, half obsolete, a unit built only a year before. The old unit has to compete by lower prices, and make smaller profits. The newer unit is called upon to bear no burdens in aid of the reduced capital values of the old. It may be that the enhanced profits of the one added to the reduced profits of the other make an average return upon capital not far different from the average that would result in a community where orderly introduction on a renewal basis is the rule. Or perhaps the community gets some of its novelties rather earlier under competitive conditions and pays a higher rate of interest for them as a net cover for the risks of obsolescence. Waste of capital would be at a minimum if the 'physical' life of before wearing out were as short as the 'social' life of the machine. To make a thing so well that it will last 'for ever' is nothing to boast about if it will be out of fashion in a few years.

Scientists often look at the problem of practical application as if getting it as rapidly as possible were the only factor to be considered in social advantage, and this difference in the position of monopoly or single management in their ability to 'hold up' new ideas is treated as a frustration in itself. Thus it has been said 'the danger of obsolescence is a great preventative of fundamental applications to science. Large firms tend to be excessively rigid in the structures of production.' Supposing that the obsolescence in question is a real factor of cost, it would fall to be reckoned with in the computation for transition, whatever the form of society, and even if the personal 'profit' incentive were inoperative. It cannot be spirited away. A customary or compulsory loading of costs for short life obsolescence would retard uneconomically rapid competition of novelties and could be scientifically explored.

Now let us look at displaced labour and the costs of it. If the effect of diversion of demand through invention is to reduce the scope or output of particular industries or concerns in private management, they have no option but to reduce staff. If the pressure is not too great, or the change too rapid, this does not necessarily result in dismissals, for the contraction of numbers may be made by not filling up, with young people, the vacancies caused by natural wastage, through death and retirement. But where dismissals are inevitable, re-engagements may take place quickly in the competing industries, otherwise unemployment ensues. Any resulting burden does not fall upon the contracting and unprofitable industry—it has troubles enough of its own already. Nor is it put upon the new and rising industry, which is attracting to itself the transferred profits. In the abstract, it might be deemed proper that before the net gains of such an industry are computed or enjoyed it should bear the burdens of the social dislocation it causes by its intrusion into society. In practice, it would be difficult to assess its liability under this head, and in fact even if it could be determined, new industries have so many pioneer efforts and losses, so many failures, so many superseded beginnings, that it might well be bad social policy to put this burden upon them, for they would be discouraged from starting at all, if they had to face the prospect of such an overhead cost whatever their results. It would, of course, be theoretically possible to put a special levy on those new industries that turned out to be profitable, and to use it to relieve the social charges of dislocation of labour. But much the same argument could be used for the relief of obsoletism of capital. The distinction would, however, be that in the case of the capital it could be urged that the investor should have been wide enough awake to see the possibilities of the rival, whereas the worker, induced to take up employment in such a superseded industry, was a victim, and could not be expected to avoid it by prevision. In any case, the prevailing sentiment is rather to encourage developing industries, than to put special burdens upon them, in order that the fruits of science may be effectively enjoyed by society with as little delay as possible.

In the upshot, therefore, the injuries to labour, though not to capital, are regarded as equitably a charge to be borne by society in general through taxation, and to be put upon neither the causing nor the suffering business unit.

And it may well be assumed that taken throughout, the gains of society as a whole from the rapid advance are ample enough to cover a charge for consequential damages. But society is not consciously doing anything to regulate the rate of change to an optimum point in the net balance between gain and damage.

The willingness of society to accept this burden is probably mainly due to the difficulty of fairly placing it, for we find that when it *can* actually be isolated and the community happens fortuitously to have a control, or the workers a power to induce, it will be thrown, not upon the attacking industry, if I may so call it, but upon the defender. Thus in the United States recently, the price of consent to co-ordinating schemes made for the railroads to reduce operating expenses, has been an agreement on this very point. If staff is dismissed, as it was on a large scale in the depression, because of fever operations and less stock in consequence of reduced carriage through the smaller volume of trade, or through road and sea competition, no attempt is made to put any of the social cost upon the railroads, and the dismissed staff become part of the general unemployed. But if the self-defence of the companies against competition takes the form of co-operation with each other to reduce operations and stock and, therefore, costs, any resultant dismissals are made a first charge upon them. The agreement is elaborate, and has the effect of preventing any adjustments which an ordinary business might readily make when it throws the burden on society, unless those adjustments yield a margin of advantage large enough to pay for their particular special effects. Thus the rapidity of adjustment to new conditions, not to meet the case of higher profits to be made at the expense of workers, but rather to obviate losses through new competition, is materially affected, and a brake is put upon the mechanism of equilibrium in this industry which does not exist in its rivals, or in any others where the power exists to throw in upon the community. A similar provision exists in the Argentine, and it is imposed by Act of Parliament in Canada, but as one of the concerns is nationally owned, and the current losses fall upon the national budget, its charge is really socially borne in the end. In this country such provisions were part of the amalgamation project of 1928, and of the formation of a single transport authority in London in 1933 and, therefore, did not arise through steps taken to meet new factors of competition. But the opportunity for their imposition came when rights to road powers and rights to pooling arrangements were sought by the railways—both of them adjusting mechanisms to minimise the losses due to the impact of new invention—and this was clearly a specialised case of keeping the burdens off society. In the case of the electricty supply amalgamation of 1933, brought about for positive advantages rather than in defence against competition, similar provision was made, and parliamentary powers for transfers to gas and water undertakings, also not defensive against innovation, have been accompained by this obligation. In the case of such uncontrolled businesses as Imperial Chemicals and Shell Mex, rationalising to secure greater profits, rather than fighting rearguard actions to prevent losses, obligations to deal with redundancies had been voluntarily assumed. In such cases the public obloquy of big business operations inimical to society can be a negative inducement, but some freedom from radical competition in prices provides a positive power to assume the burden initially, and pass it forward through price to consumers, rather than back against shareholders. The third case, however, of making it a net sharge on the improved profits, is quite an adequate outlet. If the principle of putting this particular obstacle in the way of adjustments to meet new competition (as distinct from increasing profits) is socially and ethically correct, it is doubtful whether it is wisely confined to cases where there is quite fortuitously a strategic control by public will.

It will be clear that the difference between the introduction by purely competitive elements involving premature absolescence and unemployment, and by delayed action, is a cost to society for a greater promptness of accessibility to novelty. The two elements of capital and labour put out of action, would have supplied society with an extra quantity of existing classes of goods, but society prefers to forego that for the privilege of an earlier anticipation of new things. I estimate this price to be of the order of three per cent. of the annual national income. But when we speak of social advantage, on balance, outweighing social cost, we dare not be so simple in practice. If the aggregate individual advantage of adopting some novelty is $100x$ and the social cost in sustaining the consequential unemployed is $90x$, it does not follow that it is a justifiable bargain for society. The money cost is based on an economic minimum for important reasons of social repercussions. But the moral effects of unemployment upon the character and happiness of the individual escape this equation altogether, and are so great that we must pause upon the figures. What shall it profit a civilisation if it gain the whole world of innovation and its victims lose their souls?

So far I have treated the problem of innovation as one of uneconomic rapidity. But there is another side —that of improvident tardiness. Enormous potentialities are seen by scientists waiting for adoption for human benefit, under a form of society quicker to realise their advantage, readier to raise the capital required, readier to pay any price for dislocation and to adjust the framework of society accordingly. A formidable list of these potentialities can be prepared, and there is little doubt that with a mentality adjusted for change, society could advance much more rapidly. But there is a real distinction between the methods of adopting whatever it is decided to adopt, and the larger question of a more thoroughgoing adoption. In proportion as we can improve the impact of the present amount of innovation, we can face the problem of a larger amount or faster rate. Unless most scientific discoveries happen to come within the scope of the profit motive, and it is worth someone's while to supply them to the community, or unless the community can be made sufficiently scientifically minded to include this particular demand among their general commercial demands, or in substitution for others, nothing happens—the potential never becomes actual. It has been computed that a benevolent dictator could at a relatively small expense, by applying our modern knowledge of diet, add some two inches to the average stature and seven or eight pounds to the average weight of the general population, besides enormously increasing their resistance to disease. But dictators have disadvantages, and most people prefer to govern their own lives indifferently, rather than to be ideal mammals under orders. To raise their own standard of scientific appreciation of facts is the better course, if it is not utopian. It has been clear for long enough that a diversion of part of the average family budget expenditure from alcohol to milk would be of great advantage. But it has not happened. If the individual realised the fact, it certainly might happen. It is ironically remarked that the giving of free milk to necessitous children, with all the net social gain that it may bring about, has not been a considered social action for its own sake, but only the by-product emergency of commercial pressure—not done at the instance of the Ministry of Health or the Board of Education, but to please the Milk Marketing Board by reducing the surplus stocks of milk in the interests of the producer!

Scientists see very clearly how, if politicians were more intelligent, if business men were more disinterested and had more social responsibility, if governments were more fearless, far-sighted, and flexible, our knowledge could be more fully and quickly used to the great advantage of the standard of life and health—the long lag could be avoided, and we should work for social ends. It means, says Mr. Julian Huxley, 'the replacement of the present socially irresponsible financial control by socially responsible planning bodies.' Also, it obviously involves very considerable alterations in the structure and objectives of society, and in the occupations and pre-occupations of its individuals. Now a careful study of the literature of planning shows that it deals mainly with planning the known, and hardly at all with planning for changes in the known. Although it contemplates 'planned' research, it does not generally provide for introducing the results of new research into the plan, and for dealing with the actual *impact*—the unemployment, redirection of skill, and location, and the breaking of sentimental ties that distinguish men from robots. It seems to have not many more expedients for this human problem than our quasi-individualist society with its alleged irresponsibility. It also tends to assume that we can tell in advance what will succeed in public demand and what will be superseded. There is nothing more difficult, and the attempt to judge correctly under the intellectual stimulus of high profits and risk of great losses is at least as likely to succeed as the less personally vital decision on a committee. Would a planning committee, for example, planning a new hotel in 1904, have known any better than capitalist prevision that the fifteen bathrooms then considered adequate for social demand, ought really to have been ten times that number if the hotel was not to be considered obsolete thirty years later? Prevision thought of in terms of hindsight is easy, and few scientists have enjoyed the responsibility of making practical decisions as to what the public will want far ahead. They, therefore, tend to think of prevision in terms of knowledge and appreciation of particular scientific possibilities, whereas it involves unknown demand schedules, the unceasing baffling principle of substitution, the inertia of institutions, the crusts of tradition and the queer incalculability of mass mind. Of course, in a world where people go where they are told, when they are told, do what they are instructed to do, accept the reward they are allotted, consume what is provided for them, and what is manifestly so scientifically 'good for them' these difficulties need not arise. The human problem will then be the 'Impact of Planning.' I am not here examining the economics of planning as such, but only indicating that it does not provide automatically the secret of correct prevision in scientific innovation. When correct prevision is possible a committee can aim at planning with a minimum disturbance and wastage (and has the advantage over individuals acting competitively), but for such innovation as proves to be necessary it does not obviate the human disturbance or radically change its character. The parts of human life are co-ordinated and some are more capable of quick alteration than others, while all are mutually involved. One may consider the analogy of a railway system which has evolved, partly empirically and partly consciously, as a co-ordinated whole. Suddenly the customary speed is radically changed, and then it may be that all the factors are inapporpriate—distance between signals, braking power, radius of curves, camber or super-elevation, angles of crossings, bridge stresses. The harmony has been destroyed. Especially may this be the case if the new factor applies to some units only, and not to all, when the potential density of traffic may be actually lessened. The analogy for the social system is obvious, and its form of government matters little for the presence of the problem, though it may be important in the handling of it.

I have spoken as though the normal span of life of men and machinery themselves provides a phase to which scientific advance might be adjusted for a completely smooth social advance. But this would be to ignore customs and institutions, even as we see in Federal America, Australia and Canada, constitutions which lengthen that phase and make it less amenable as a natural transition. At one time we relied on these to bring about the economic adjustment necessary. But technical changes take place so rapidly that such forces work far too slowly to make the required adaptation. Habits and customs are too resistant to change in most national societies to bring about radical institutional changes with rapidity, and we patch with new institutions and rules to alleviate the effects rather than remove the causes of maladjustments. The twenty mile speed limit long outstayed its fitness, and old building restrictions remained to hamper progress. Edison is reported to have said that it takes twenty-five years to get an idea into the American mind. The Webbs have given me a modal period of nineteen years from the time when an idea comes up as a practical proposition from a 'dangerous' left wing to the date when it is effectively enacted by the moderate or 'safe' progressive party. This period of political gestation may be a function of human psychology or of social structure. We do not know how ideas from a point of entry, permeate, infiltrate or saturate society, following the analogues of conduction, convection, or lines of magnetic force.

Our attitude of mind is still to regard change as the exceptional, and rest as the normal. This comes from centuries of tradition and experience, which have given us a tradition that each generation will substantially live amid the conditions governing the lives of its fathers, and transmit those conditions to the succeeding generation. As Whitehead says: 'we are living in the first period of human history for which this assumption is false.' As the time span of important change was considerably longer than that of a single human life, we enjoyed the illusion of fixed conditions. Now the time span is much shorter, and we must learn to experience change ourselves.

I have so far discussed modification of impact to meet the nature of man. Now we must consider modifying the nature of man to meet impact.

Sociologists refer to our 'cultural lags' when some of the phases of our social life change more quickly than others and thus get out of gear and cause maladjustments. Not sufficient harm is done to strike the imagination when the change is a slow one, and all the contexts of law, ethics, economic relations and educational ideals tend towards harmony and co-ordination. We can even tolarate by our conventions, gaps between them when preachers and publicists can derive certain amusement and profit from pointing out our inconsistencies. But when things are moving very rapidly, these lags become important; the concepts of theology and ethics, the tradition of the law, all tend to lag seriously behind changes brought about through science, techincal affairs and general economic life. Some hold that part of our present derangement is due to the lack of harmony between these different phases—the law and governmental forms constitutionally clearly lag behind even economic developments as impulsed by scientific discovery. An acute American observer has said that 'the causes of the greatest economic evils of to-day are to be found in the recent great multiplication of interferences by Government with the functioning of the markets, under the influence of antiquated doctrines growing out of conditions of far more primitive economic life.' It would be, perhaps, truer to say that we are becoming 'stability conscious' and setting greater store, on humanitarian grounds, by the evil effects of instability.

In the United States it would be difficult to find, except theoretically in the President, any actual person, or instrument in the Constitution, having any responsibility for looking at the picture of the country as a whole, and there is certainly none for making a co-ordinated plan. Indeed, in democracy, it is difficult to concieve it, because the man in public life is under continual pressure of particular groups, and so long as he has his electoral position to consider, he cannot put the general picture of progress in the forefront. Whitehead declared that when an adequate routine, the aim of every social system, is established, intelligence vanishes and the system is maintained by a co-ordination of conditioned reflexes. Specialised training alone is necessary. No one, from President to miner, need understand the system as a whole.

The price of pace is peace. Man must move by stages in which he enjoys for a space a settled idea, and thus there must always be something which is rather delayed in its introduction, and the source of sectional scientific scorn. If every day is 'moving' day, man must live in a constant muddle, and create that very fidget and unrest of mind which is the negation of happiness. Always 'jam to-morrow' —the to-morrow that 'never comes.' If we must have quanta of stages, the question is their optimum length and character, not merely the regulation of industry and innovation to their tempo, but the education of man and society to pulse in the same rhythmic wavelength or its harmonic.

In some ways we are so obsessed with the delight and advantage of discovery of new things that we have no proportionate regard for the problems of arrangement and absorption of the things discovered. We are like a contractor who has too many men bringing materials on to the site, and not enough men to erect the buildings with them. In other words, if a wise central direction were properly allocating research workers to the greatest marginal advantage, it would make some important transfers. There is not too much being devoted to research in physics and chemistry, as modifying industry, but there is too much relatively to the research upon the things they affect, in physiology, psychology, economics, sociology. We have not begun to secure an optimum balance. Additional financial resources should be applied more to the biological and human sciences than to the applied physical sciences, or possibly, if resources are limited, a transfer ought to be made from one to the other.

Apart from the superior tone sometimes adopted by 'pure science' towards its own applications, scientific snobbery extends to poor relations. Many of the hard-boiled exprimental scientists in the older and so productive fields, look askance at the newer borderline sciences of genetics, eugenics and human heredity, psychology, education, and sociology, the terrain of so much serious work but also the happy hunting ground of 'viewey' cranks and faddists. Here the academic soloist is still essential, and he has no great context of concerted work into which to fit his own. But unless progress is made in these fields which is comparable with the golden ages of discovery in physics and chemistry, we are producing progressively more problems for society than we are solving. A committee of population experts has recently found that the expenditure on the natural sciences is some eight to ten times greater than that on social sciences. There is hardly any money at all available for their programme of research into the immense and vital problems of population in all its qualitative and quantitative bearings. An attack all along the front from politics and education to genetics and human heredity is long overdue. Leisure itself is an almost unexplored field scientifically. For we cannot depend wholly on a hit and miss process of personal adaptation, great though this may be. There must be optimal lines of change which are scientifically deteminable. We have seen in a few years that the human or social temperament has much wider range of tolerance than we had supposed. We can take several popular examples. The reaction to altered speed is prominent. In the *Creevey Papers*, it is recorded that the Knowsley party accomplished 28 miles per hour on the railway, and recorded it as 'frightful—impossible to divest yourself of the notion of instant death—it gave me a headache which has not left me yet—some damnable thing must come of it. I am glad to have seen this miracle, but quite satisfied with my first achievement being my last.' In the British Association meeting for 1836, an address on Railway Speeds prophesied that some day 50 miles an hour might be possible. Forty years ago we may remember that a cyclist doing 15 to 18 miles an hour was a 'scorcher' and a public danger. Twenty-five years ago, 30 miles an hour in motoring was an almost unhealthy and hardly bearable pace. To-day the fifties and sixties are easily borne, both by passenger and looker on. Aeroplane speeds are differently judged, but at any rate represent an extension of the tolerance. Direct taxation thirty years ago in relation to its effect on individual effort and action seemed to reach a breaking-point and was regarded as psychologically unbearable at levels which to-day are merely amusing. The copious protection of women's dress then would have looked upon to-day's rationality as suicidal lunacy. One hesitates to say, therefore, that resistances to scientific changes will be primarily in the difficulty of mental and physical adjustments. But there can be little doubt that with the right applications of experimental psychology and adjusted education, the mind of man would be still more adaptable. Unfortunately, we do not know wchther education as an *acquired characteristic is in* any degree inheritable, and whether increasing educability of the mass is a mere dream, so that we are committed to a sisyphean task in each generation. Nor do we know whether this aspect is affected by the induced sterility of the age. It may not be a problem of changing the same man in his limetime, but of making a larger difference between father and son. The latest teachings of geneticists hold out prospects for the future of man which we should like to find within our present grasp, and recent successful experiments with mammals in parthenogenesis and eutelegenesis bear some inscrutable expression which may be either the assurance of new hope for mankind or a devil's grin of decadence.

What is economics doing in this kaleidoscope?

The body of doctrine which was a satisfactory analysis of society twenty-five years ago is no longer adequate, for its basic postulates are being rapidly changed. It confined itself then to the actual world it knew and did not elaborate theoretical systems on different bases which might never exist. It is, therefore, now engaged in profoundly modifying the old structures to meet these new conditions. Formerly it assumed, quite properly, a considerable degree of fluid or competitive adjustment in the response of *factors of production to the stimulus or operation of* price, which was really a theory of value-equilibrium. Wherever equilibrium was disturbed, the disturbance released forces tending to restore it. To-day many of the factors formerly free are relatively fixed, such as wage levels, prices, market quotas, and when an external impact at some point strikes the organism, instead of the effect being absorbed throughout the system by adjustments of all the parts, it now finds the shock evaded or transmitted by many of them, leaving the effects to be felt most severely at the few remaining points of free movement or accommodation. Unemployment is one of these. The extene to which this fact throws a breaking strain upon those remaining free points is not completely analysed, and the new economics of imperfect competition is not fully written out or absorbed. The delicate mechanism of price adjustment with the so-called law of supply and demand governed the whole movement, but with forcible fixation of certain price elements consequences *arise in unexpected and remote quarters. Moreover,* the search for a communally planned system to secure freedom from maladjustments involves a new economics in which the central test of price must be superseded by a statistical mechanism and a calculus of costs which has not yet been staisfactorily worked out for a community retaining *some* freedom of individual action and choice. The old international currency equilibrated world forces and worked its way into internal conditions in order to do so. But the modern attempt to prevent any internal effect of changes in international trade, or counteract them, and the choice of internal price stability at all costs against variable international economic equations, has set economic science a new structure to build out of old materials. At this moment when elasticity is most wanted, stability leading to rigidity becomes a fetish. The aftermath of war is the impossibility of organising society for peace.

The impact of economic science upon society today is intense and confusing, because, addressing itself to the logic of various sets of conditions as the likely or necessary ones according to its exponents' predilections, it speaks with several voices,and the public are bewildered. Unlike their claims upon physics and mathematics, since it is dealing with money, wages, and employment, the things of everyday, they have a natural feeling that it ought to be easily understandable and its truth recognisable. Balfour once said, in reference to Kant, 'Most people prefer a problem which they cannot explain, to an explanation *which they cannot understand.*' But in the past twenty years, the business world and the public have become economics-conscious, and dabble daily in index numbers of all kinds, and the paraphenalia of foreign exchange and statistics of economic life. The relativity of economic principle to national psychology baffles the economists themselves, for it can be said truly at one and the same time, for example, that confidence will be best secured by balancing the Budget, and by not balancing it, according to public mentality. The economics of a community not economically self-conscious are quite different from those of a people who watch every sign and act accordingly. Thus the common notion that economics should be judged by its ability to forecast (epsecially to a particular date) is quite fallacious, for the prophecy, if 'true' and believed, must destroy itself inasmuch as the economic conduct involved in the forecast is different after the forecast from what it would have been before. The paradox is just here, for example: if a people are told that the peak of prices in a commodity will actually be on June 10, they will all so act that they anticipate the date and destroy it. Economics, thoroughly comprehended, can well foretell the effects of a tendency, but hardly ever the precise date or amount of critical events in those effects. The necessity for a concentration upon new theoretical and analytical analysis, and upon realistic research, is very great. But so also is the need for widespread and popular teaching. For a single chemist or engineer may by his discovery affect the lives of millions who enter into it but do not understand it, whereas, a conception in economic life, however brilliant, generally requires the conformity of the understanding and wills of a great number before it can be effective.

But not alone economics: if the impact of science brings certain evils that can only be cured by more science. Ordered knowledge and principles are wanted at every point. Let us glance at three only, in widely different fields: man's work, man's health, man's moral responsibility. The initial impact of new science is in the factory itself. The kind of remedy required here is covered by the work of the National Institute of Industrial Psychology. Some of this improves upon past conditions, some creates the conditions of greater production, but much of it combats the evils arising from new conditions created by modern demands, speed, accuracy and intensity. It invokes the aid of many branches of science. It is the very first point of impact. Yet its finance is left to personal advocacy, and commands not 10 per cent. of the expenditure on research in artificial silk, without which the world was reasonably happy for some centuries. We can judge of the scope of this by the reports of the Industrial Health Research Board. Again, the scientific ancillaries of medicine have made immense strides. Clinical medicine as an art makes tardy, unscientific and halting use of them. The public remain as credulous as ever, their range of gullibility widened with every pseudo-scientific approach. (We do not know what proportion of positive cases can create the illusion of a significant majority in mass psychology, but I suspect that it is often as low as twenty per cent.). For a considerable range of troubles inadequately represented in hospitals, the real experience passes through the hands of thousands of practitioners, each with too small a sample to be statistically significant, and is, therefore, wasted from a scientific standpoint. Half-verified theories run riot as medical fashions, to peter out gradually in disillusionment. If the scattered cases were all centralised through appropriately drawn case-histories, framed by a more scientifically trained profession, individual idiosyncrasy would cancel out, and mass scrutiny would bring the theories to a critical statistical issue of verification or refutation in a few months. This would be to the advantage of all society, and achieve an even greater boon in suggesting new points for central research.

A suggestion has been made for an inventions clearing house, to 'co-operate the scientific, social and industrial phases of Invention, and to reduce the lag between invention and application' managed by a committee of scientists and a committee of industrialists and bankers. The proposal came to me from New York, but London was to be the home of the organisation, which was to adopt a code of ethics in the interests of inventors, industry and *social progress*. This brings me to my third example, the field of ethics, which needs the toil of new thought. The systems of to-day, evolving over two thousand years, are rooted in individualism and the relations between individuals. But the relations of society to-day are not predominantly individual, for it is permeated through and through with corporate relations of every kind. Each of these works over some delegated area of the individual's choice of action, and evolves a separate code for the appropriate relationship. The assumption that ethical questions are decided by processes which engage the individual's whole ethical personality is no longer even remotely true. The joint stock company may do something, or refrain from doing something, on behalf of its shareholders, which is a limited field of ethics, and may but faintly resemble what they would individually do with all other considerations added to their financial interests. The whole body of ethics needs to be reworked in the light of modern corporate relations, from Church and company, to cadet corps and the League of Nations.

In no case need we glorify change: but true rest may be only ideally controlled motion. The modern poet says:

'The endless cycle of idea and action,
Endless invention, endless experiment,
Brings knowledge of motion, but not of stillness.'

But so long as we are to have change—and it seems inevitable—let us master it. T. S. Eliot goes on:

'Where is the wisdom we have lost in knowledge?
Where is the knowledge we have lost in information?'

My predecessors have spoken of the shortcomings of the active world—to me they are but the fallings short of science. Wherever we look we discover that if we are to avoid trouble we must take trouble—scientific trouble. The duality which puts science and man's other activity in contrasted categories with disharmony to be resolved, gaps to be bridged, is unreal. We are simply beholding ever-extending science too rough round the edges as it grows.

What we have learnt concerning the proper impact of science upon society in the past century is trifling, compared with what we have yet to discover and apply. We have spent much and long upon the science of matter, and the greater our success the greater must be our failure, unless we turn also at long last to an equal advance in the science of man.

Research Notes

Discovery of Antiquities in the District of Dinajpur in Bengal

In a very interesting communication (*Journal of the Royal Asiatic Society of Bengal*, Letters, 2, 9-19, 1936) Mr. Sarasi Kumar Saraswati publishes the report of his fourth archaeological tour in the district of Dinajpur. He is the first scholar to discover interesting images in the places called Itahar, Bhadrasila, Bankur, Sonapur, Yogipara, Baigungaon, Shadea, Dhulohar which are the sites of the ancient cities. The discovered images represent Yogāsana Vishnu, Gangā, Sūrya, Revanta, Buddha. There is one specimen which is unidentified (plate 3, FIG. 6). These images belong to the Pāla and Sena ages. In the conclusion the author has rightly observed, "From the foregoing pages it is apparent that the area traversed during the short trip was once full of ancient and prosperous settlements adorned with imposing palaces, beautiful temples and large tanks...... The relics that lie above ground fully demonstrate the antiquity and importance of the different sites, which, if properly explored and excavated, are expected to yield valuable and interesting results for the history of this part of the country, and, it may be, even for the history of Bengal."

C. C. Das Gupta.

On the Rock Paintings of the Mahadeo Hills

Lovers of Indian painting will remain thankful to Major D. H. Gordon, D. S. O., for his very important communication entitled "The rock paintings of the Mahadeo Hills." (*Indian Arts and Letters 20*, 35-41, 1936). The Mahadeo Hills are situated in Chindwara districts in Central Provinces. According to the author's opinion this hill affords shelter for dwelling because "weathering has shaped the soft sandstone cliffs, scooping them out to form an overhanging roof as a protection from the rain." These shelters are located in places called Jambu Dwip nullah, Monte Rosa, Dorothy Deep, Marodeo, Bori, Tamia, Son Bhadra, Jhalai, Adamgarh. In these shelters there are the rock paintings which form the subject-matter of the present article. Dr. G. R. Hunter was the first scholar to give a lecture on these paintings before the Congress of Pre- and Proto-historic Sciences in 1932. According to the opinion of Major Gordon these paintings might be divided into five chronological groups on the evidence furnished by style and technique. The first four groups might each be subdivided into early and late. It should be noted that for the chronological arrangement the author has accepted the hypothesis that the paintings which are more naturalistic are earlier.

"The first series is characterized by its stylized technique." The early first series is mainly characterized by the diagrammatic figures, and is drawn in dark red and cream. The late first series is characterized by the convention for indicating the articulation of the limbs.

"With the change to the second series we have an abrupt alteration of style, only two figures showing a possible link." The chief characteristics of this series are bad drawing and anatomical exaggeration. In the early second series the figures have blobs for heads and weavy bands for limbs. In the late second series there are attempts at narrative grouping.

"With the development of the third series a great change comes over the paintings; one notices a rapid progress of artistic ability, an all-round improvement only marred by occasional ineptitude." In this series we find many paintings depicting the social life. In the early third series we find the figures painted in dark red and pink with the occasional ones in white. In the late third series the figures are in white with a very few in pink.

In the early fourth series we find the white figures with red outline. The late fourth series retains the white figures with a red outline. But these figures are ill-drawn.

The fifth series consists of a few badly drawn figures of elephant and sambhur painted in greenish yellow ochre.

Regarding the age of these rock paintings the author observes, "A lowest limit of roughly the tenth century may, we feel, be provisionally accepted, and we do not consider that, at the outside, the development of this art from the early first series could have occupied a period of more than 1500 years."

C. C. Das Gupta.

On Folk Arts of Bengal

In a very interesting communication entitled "The living traditions of the folk arts in Bengal" (*Indian Arts and Letters*, *10*, 22-34, 1936) Mr. G. S. Dutta, I.C.S., has most enthusiastically dealt with the folk arts of Bengal. In some sense Dr. Abanindra Nath Tagore was the first scholar who gave a great impetus to the researches in folk arts of Bengal by publishing the fascinating work *L' Alpona, ou les decorations rituelles au Bengale* in 1921. It is regrettable that though some scholars have published interesting papers on this subject after 1921, yet nobody, as it should have been, has taken up the study of this highly interesting folk art of Bengal as his life's work. Mr. Dutt has followed the example set by Dr. Tagore and has already done a good deal of research work on the folk arts of Bengal (*Journal of the Indian Society of Oriental Art*, *1*, 18-25, 1933; *Modern Review*, *51*, 519-29, 1932; *Ibid*, *52*, 44-52, 1932; *Ibid*, *53*, 520-29, 1932). First, he refers to the *Bāul*, *Kīrtan*, *Brata*, *Jhumur*, *Rāibeshe*, *Dhāli* and *Kāthi* dances of Bengal. In the decorative floor design there is always an attempt to have the synthesis of various patterns and designs. The same is also the case with the decorative wall design. In pottery painting also the villagers show great skill in form and design. The motifs are generally taken from nature and religious subjects. In cottage architecture also the villagers of Bengal excel so far as patterns and designs are concerned. The villagers of Bengal also take great delight in wood carving. The author has illustrated one example of wood carving which represents Durgā in the middle, Lakshmi and Kārttikeya on her right side and Sarasvati and Ganesa on her left side (fig. 4). It is an excellent work of this art, there being a pleasing plastic unity in the whole composition. Lastly, he deals with the art of rural painting. According to him the rural painting is of two classes, *viz*, secular and ritualistic. In this connection he has referred to the decorative paintings on the ceremonial *kulās* or winnowing trays and the *pat*-painting or the scroll-painting. He has has rightly observed that the essential features of the *pat*-painting of Bengal "are an extreme boldness of line and colour and an inherent genius for design, the subject-matter of the picture being fused into the structure of the pictorial work and thus achieving a remarkable combination of the best qualities of abstract and naturalistic art."

C. C. Das Gupta.

Ascorbic Acid in Blood Serum & Plasma

The usual method of estimation of vitamin C in tissues and food materials had been (1) extraction of the substance with trichloroacetic acid (2) titration of the trichloroacetic extract against the standard Tillmans reagent. The trichloroacetic acid solution dissolves the vitamin, but precipitates the protein, etc., the presence of which might interfere with end point in titration. But it is well known that trichloroacetic acid itself reduces the indicator. So in estimation of ascorbic acid content of blood plasma sodium-tungstate and sulphuric acid were used instead of trichloroacetic acid by Farmer and Abt. This method with slight modification has been utilized by Taylor, Chase and Faulkner (*Biochem J.*, *30*, 1119, 1936) for determination of ascorbic acid in blood serum.

Two c. c. of fresh blood serum is put into a fifty c. c. centrifuge tube with 14 c. c. water and 2 c. c. 5% Na-tungstate, 2 c. c. N/3 H_2SO_4 are then added and the whole thing mixed together and centrifuged for ten minutes. The ppt. settles down and the supernatant liquid is decanted into a flask, 0.5 c. c. gl. acetic acid added and kept in a dark place in a stoppered flask. The ppt. is then redissolved in 2 c. c. 5% Na-tungstate, water added up to 14 c. c.

and then 2 c. c. N/3 H_2SO_4 again added to precipitate the protein, centrifuged and the supernatant liquid containing the ascorbic acid decanted. This is repeated 4 times, all the washings mixed up and finally titrated against the usual standard Tillmans reagent. By this process a very good agreement has been found between the ascorbic acid values of serum and plasma. The method is a simple and reliable procedure for the estimation of the level of ascorbic acid in blood serum or plasma, and as such it offers a useful tool for the study of the effects of diet and disease upon the metabolism of vitamin C. The authors have reproduced two typical curves illustrating the transient rise in the blood level of reduced ascorbic acid following oral and intravenous administration of pure ascorbic acid in a normal subject and in a case of clinical scurvy.

H. N. Banerjee.

B. B. Ray's Partial Absorption of X-Rays and the Structure of the Compton Band

In 1930 Prof. B. B. Ray of Calcutta found that when monochromatic X-rays are passed through carbon, nitrogen and oxygen new lines make their appearance on the long wave-length side of the transmitted beam and are separated from it by a distance corresponding to the energy of the K electrons of the elements in question. The explanation preferred by him was that in the interaction between a quantum and a K electron the former loses a part of its energy and an equivalent part of its momentum during its passage through the medium, and that the electron is raised from one level to another or removed completely from the atom. The remaining energy is then propagated with a new momentum in the original direction as a wave of lower frequency.

The observation of the phenomenon, called by the author "a partial absorption of X-rays", though verified by some, could not, however, be confirmed by others, and hitherto remained unexplained.

In a recent issue of the *Physical Review* (*50*, 38, 1936), Sommerfeld has drawn attention to several facts connected with the structure of the Compton band, which incidentally contain a possible explanation of the observations of Ray. The Compton radiation from bound electrons consists of a continuous band, the structure of which has been calculated by many on different assumptions. The point to which Sommerfeld draws attention is that such a band will have a definite limit on the short wave side, *i.e.* towards the unmodified Rayleigh line, the position of which corresponds to a zero value for the kinetic energy of the recoil electron, and is a function of the angle of scattering. Calculations for hydrogen show that at a scattering angle $\theta = 13\frac{1}{2}°$ and for $\lambda = 1.5$ Å, the limit cuts the Compton band precisely in its centre, and for values of θ nearly 0 the Compton band will be cut on the other side of its centre and the remaining part may, in extreme cases, be very small.

The "very weak, broad, diffuse line on the long wave-length side of the primary line which appeared to have a more or less definite edge on its short-wave side" as observed by Ray reminds one of the above structure of the tail of the Compton band to be observed at very small angles of scattering. In the case of carbon or the other elements studied, this residue would correspond to the K electrons, and the limit to the K limit. The L electrons, being much less firmly bound, would contribute only to the central part of the Compton band, which, in turn, is cut off by the limit. This coincides with Ray's observations that the lines were separated from the primary one by the energy corresponding to the K electrons.

In view of the fact that the combined Rayleigh and modified scattering is equal in intensity to the classical Thomson scattering, the question comes in: 'What becomes of the Compton band thus suppressed'? Sommerfeld answers it by saying that the energy goes into what may be called the 'X-ray Raman Spectrum' which corresponds to transitions of the reacting electron to discrete outer levels, so that instead of a recoil electron making its appearance, the atom is left in an excited state with the electron bound to it. This Raman Spectrum lies within the Rayleigh line and the limit of the Compton band. Now that attention has been drawn to the possible existence of such spectra and the place where to look for it, it may not be long before their detention is reported.

D. P. Ray-Chaudhury.

RESEARCH NOTES

Hormones and Evolution

Long before Bayliss had established the theory of the hormones and "some ten years before the publication of Darwin's *Origin of Species*, an experimentalist named Berthold exposed for the first time a specific hormonal mechanism, by showing that an internal secretion of the testes is responsible for the development of secondary sexual characters in birds", said Dr. Zuckerman (*Man*, August, 1936) in course of a lecture delivered before the Royal Anthropological Institute. Dendy in 1911 suggested that changes in the endocrine system might be responsible not only for the individual but also for racial characters. Sir Arthur Keith has also advanced the same view in a large number of papers and in 1922 he clearly brought out the exact significance of the hormones in relation to the evolutionary problem. He suggested that the physical differences between Negroes, Mongols, and Europeans are due to the differences in their respective endocrine systems. This conclusion has very recently been elaborated by J. R. Marett[1].

In the course of his lectures Dr. Zuckerman examined the following three essential points :—

"(*a*) What significance is to be attached in evolutionary discussion to the view that the endocrine system is responsible for physical and psychological characteristics ?

(*b*) What value is to be attached to Bolk's view of the endocrine mechanism through which man has become a foetalized primate ?

(*c*) Does the so-called hormone theory of evolution in fact reveal some novel evolutionary mechanism, or does it merely push the main problem one step farther back by insinuating hormones between the known processes concerned in evolutionary change and the structures whose evolution it is the business of physical anthropologists to consider?"

(*a*). The experimental study of embryology has shown that the developmental processes are controlled by 'organizing' substances which determine the development of the young embryo and these organizers are known to be chemical substances. These chemical evocators presumably act by diffusion through the tissues and thus they do not agree with the classical definition of a hormone. These organizing substances and hormones, of course, belong to a single class of substances concerned with the chemical regulation of form and function. Nothing is known of the individual differences in the endocrine control of embryogenesis and the simple admission of a hormonal control of development does not explain the individual differences and the various racial types. Physical and psychological characters are dependent on a hoard of other factors apart from the hormones. There are not the slightest direct experimental evidences in support of the theory of the distinctive types of endocrine balance in different individuals and different racial types.

(*b*). Bolk's views of the foetalization of man, the process through which, he is of opinion, man is differentiated from the primates, also lack in proper definition. Bolk postulates a general process of slowing down in embryogeny, as well as a process of neotony, whereby general foetal characters which are everlaid as development proceeds in other primates become part of the mature human form. He also insists on the manner of the evolution of the human form and not human phylogeny but his theory can only be evaluated against an acceptable phylogeny. Further, if man is a foetalized primate in respect of the chimpanzee and if human and chimpanzee's evolutions are independent processes, then the matter of foetalization will be of little interest. It has yet to be found out whether or not there has been an orderly process of foetalization, as Bolk says, in the course of primate evolution or it is a general primate potentiality which has become expressed in man without any manifestation in other orders of mammals. Bolk explained the process of retardation of human development (length of intra-uterine life, times of tooth eruption, onset of puberty) and foetalization by hormonal mechanisms, but none can accept his view on the pineal gland elaborating a secretion to slow down the whole developmental process. Growth processes are, of course, influenced by hormonal mechanism but the details of their inter-relations have only been superficially explained.

(*c*). Even though we can not grasp the course fo foetalization by which it is said, human characteristics have evolved and growth processes are controlled by an endocrine mechanism it is assumed that human evolution has proceeded by a series of changes in the human endocrine complex. "This conclusion is hardly as startling as certain authors have pretended" writes Dr. Zuckerman. The endocrine system, in its widest possible sense, is a medium through which evolutionary changes are expressed and it is no less genetically determined than is every other character. We have no knowledge of any effect of it, however sensitive it be to environmental stimulation being transmitted to the succeeding generation. In fact, there is no authority to assume that evolutionary changes in the endocrine complex has been effected in any way except by gene mutation.

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[1] Marett's book has been reviewed by Dr. B. S. Guha in the last issue of this Journal.

The hormones play an important part in the shaping of human characteristics and in the control of ontogenetic processes in evolution. These have no bearing on the course of human evolution. Hormones are only one aspect of the developmental processes and the available facts of endocrinology are not sufficient enough to interpret the make up of the various racial types. We must not forget that the tissues of the organism are not entirely plastic and at the mercy of any hormone and the question of tissue specificity remains to be a more significant problem.

S. S. Sarkar.

In the last issue of this JOURNAL *read* after the last line of the first column of p. 162
"$C_8H_{14}O_6$. It contained two —OCH_3 groups. When the acid"
etc. as in the first line of the second column.

Regarding his letter published on p. 164 of the last issue of the JOURNAL, Mr. S. S. Sarkar informs us that "the Oraons are not tapeinocephalic but are acrocephalic like the Malers and their face is leptoprosopic and not mesoprosopic."

University and Academy News

Indian Physical Society

An ordinary meeting of the Indian Physical Society was held on 9th September, 1936, in the Applied Physics Seminar, University College of Science, 92 Upper Circular Road, Calcutta.

The following gentlemen were elected to Fellowship of the Society :—

1. Prof. S. N. Bose, Head of the Department of Physics, Dacca University.
2. Mr. B. N. Sinha, Department of Physics, Benares Hindu University.
3. Mr. N. Misra, Professor of Physics, Ravenshaw College, Cuttack.
4. Mr. P. N. Sen Gupta, Department of Physics, Ashutosh College, Calcutta.
5. Mr. T. K. Deolalkar, Head of the Department of Physics, Karnatak College, Dharwar.
6. Mr. R. V. Barave, Professor of Physics, Fergusson College, Poona.
7. Mr. M. Sen Gupta, Professor of Electrical Engineering, Bengal Engineering College, Howrah.
8. Mr. S. P. Chakravarti, Lecturer in Applied Physics, Calcutta University.
9. Mr. A. N. Banerjee, Professor of Physics, Ripon College, Calcutta.
10. Mr. A. C. Ghosh, Ghosh Laboratory of Physics, Calcutta University.
11. Mr. J. N. Bhar, Ghosh Laboratory of Physics, Calcutta University.
12. Mr. S. R. Das, Khaira Laboratory of Physics, Calcutta University.
13. Mr. S. B. Chaudhuri, Khaira Laboratory of Physics, Calcutta University.

The following papers were read and discussed :—

(i) On the Linearity of the Lorentz Transformation, By Mr. B. C. Mukherjee.

(ii) X-ray Studies on Electro-deposited Silver, By Mr. Hussain, Patna.

(iii) On a proposed form of the Principle of Equivalence and Deduction of Lorentz Transformation, By Prof. N. R. Sen, Calcutta.

(iv) Ultraviolet Absorption spectra of Pr^{+++} and Nd^{+++} Ions in Solution, By Mr. P. C. Mukherjee.

(v) Dissociative Equilibrium and Pair Generation, By Mr. Jaikissen, Lahore.

(vi) On the Wing accompanying the Rayleigh Line in Liquid Mixtures. Part I, By Dr. S. C. Sircar and Mr. B. K. Mukherjee.

(vii) On the Ultraviolet Absorption Spectra of the Paramagnetic salts in solution and the nature of chemical Linkage in them, By Mr. S. Datta and Mr. M. Deb.

Royal Asiatic Society of Bengal

An ordinary monthly meeting of the Royal Asiatic Society of Bengal was held on Monday, the 7th September, 1936, at 5-30 p. m.

The following candidates were balloted for as ordinary members :

(1) Singh Roy, The Hon'ble Sir Bijay Prasad, Kt., Minister, Government of Bengal.

(2) Singha, Jadunath, M. A., PH. D., Premchand Roychand Scholar, Professor of Philosophy, Meerut College, Meerut.

(3) Ram, Daulat, Accountant, Military Secretary's Office, Patiala.

(4) Bagchi, Kumar Nath, Rai Bahadur, B. SC., M. B. (Cal.), D. T. M. (Cal. & L'pool), F. I. C. (Lond.), Chemical Examiner to the Government of Bengal, Medical College, Calcutta.

(5) Williams, N. T. ,Calcutta.

The National Academy of Sciences, India

The ordinary monthly meeting of the National Academy of Sciences, India, was held in the Physics Lecture Theatre, Muir College Buildings, Allahabad,

on the 15th of September, 1936, at 4 p. m., with Prof. N. R. Dhar, President of the National Academy, in the chair.

The Imperial Council of Agricultural Research, Simla, has given as a grant to the National Academy of Sciences, India, the sum of Rs. 500/- per annum for three years for expenditure on publication of scientific work.

The following papers were read and discussed :—

1. Binayendra Nath Sen, Burdwan (Bengal): On the Direct Formation of Iodides and the Distance of the Closest approach of Atoms of Iodine.
(2) R. K. Shastry, Benares: Theorems Connecting different classes of Self-reciprocal Functions.
(3) Ram Behari, Delhi: Curved Asymptotic Lines of ruled Surfaces.

The following were elected members of the National Academy of Sciences, India, :—

1. Mr. Birendra Kumar Bhatnagar, Allahabad.
2. Mr. Hrishikesha Trivedi, Physics Department, Lucknow University, Lucknow.

Indian Chemical Society

The third ordinary meeting of the Indian Chemical Society was held on Friday, the 28th of August, 1936, at 5 p. m. in the Chemistry Lecture Theatre, University College of Science, 92, Upper Circular Road, Calcutta. Professor Dr. B. B. Dey was in the chair.

1. The following gentlemen were admitted as Fellows, their subscription having been received for the first time :

> G. P. Pendse, Esq., M. Sc. (Gwalior); Dr. Surendra Nath Ray, M. Sc., Ph. D. (Calcutta); Kalipatnapu Kondaiah Esq., M. Sc. (Benares); S. Raju Esq., M. Sc. (Benares); Prof. Satyendra Nath Bose, M. A. (Dacca); Dr. Lavji Thoria ; Dr. Ing. (Bombay); Akundi Jogarao, Esq., M. Sc. (Benares); Sarju Prasad Esq. M. A., M. Sc. (Benares); G. R. Phansalkar, Esq., M. Sc. (Benares); Dhirendra Nath Majumder, Esq., M. Sc., A. I. I. Sc. (Benares).

2. The following gentlemen were elected as Fellows by ballot, Dr. K. N, Bagchi and Dr. P. C. Mitter acting as scrutators :

> Gyanendra Nath Banerjee Esq, (Bombay); Mahadeo Ganesh Kale Esq., M. A. (Bombay); Nirmalendu Nath Ray, Esq., M. Sc. (Rajahahi) Nadiabehari Adhikari Esq., M. Sc. (Calcutta); H. Ramaswamy Iyengar Esq. (Mysore); S. Venkata Rao, Esq., M. Sc. (Bangalore) ; Dr. K. S. Nargund, M. Sc., Ph. D. (Ahmedabad); P. D. Swami, Esq., B.Sc. Visharad, (Benares) ; Dr. Pulin Behari Sarkar, D. Sc. (Calcutta) ; Baradananda Chatterjee Esq. M. Sc. (Calcutta); Narayan Chandra Sen Gupta Esq. (Calcutta).

3. Prof. Dr. J. C. Ghosh delivered the lecture on "Recent work on the Oxidation-reduction Potential of Systems of Biological interest". Dr. B. B. Dey, Dr. B. C. Guha, and Dr. J. N. Mukherjeej oined in the discussion.

Book Review

Zoology for Intermediate Students—*By Vishwa Nath, M.Sc. (Panj), Ph.D. (Cantab), F.R.M.S., Pp. III + 495 + XVII with one coloured plate and 181 text-figures. Uttar Chand Kapur & Sons, Lahore, 1936.*

The increasing popularity of Zoology as a subject in the university curriculum has called forth this text-book for the Intermediate students. Dr. Vishwa Nath is an experienced teacher and a skilful researcher in cytology. He has followed the "type system" and has given a reasonably adequate account of the types included in the Intermediate syllabus of Indian universities *i. e. Amoeba, Paramaecium,* the malarial parasite, *Hydra, Obelia, Pheretima,* the cockroach, the frog and the rabbit. But the chapters dealing with cytology, evolution and genetics are particularly full and well done and these, as he says himself, "should make the book useful to the B. Sc. students as well." There is a chapter on the principles of classification and another on a general survey of the animal kingdom at the end of the book : these will, no doubt, add to the usefulness of the book for the beginners. A good feature of the book is a large number of simple diagrams which can be easily understood by the elementary students.

The book is clearly written and well illustrated and should find an extensive use in Intermediate colleges. For the next edition, which we hope will be called for before long, we would suggest a better quality of paper and a better type.

K. N. Bahl.

Intermediate Botany—*By L. J. F. Brimble. 562 pp. 337 figs. Macmillan & Co., London. Price 8s. 6d. 1936.*

This is an elementary treatise on Botany that is designed to fit the Higher School Certificate and Intermediate examinations. It resembles its predecessor, *Everyday Botany,* in method of presentation and general appearance. The style is clear and simple and technical terms are kept at a minimum. The arrangement of the text is logical and there is an adequate index at the end. As mentioned in the preface, the author has written the book with the aim that it may help "not only the general, scientifically interested reader, but also students, to take an active interest in the subject, rather than treat it merely as a dull and perhaps even useless, stile to cross towards academic distinction". In the opinion of the reviewer Mr. Brimble has accomplished his task with great success. Considerable information of human interest has been assembled in these pages. To mention only a few, the harvesting of cork, the cultivation of mushrooms, the formation of coal, medicinal plants, vitamins, grafting, budding, all find their proper place. Recent work has not been ignored. Many small references such as those about "mummy wheat" and Col. Lindbergh's Arctic flight of 1934 add charm and interest to the text and hold the reader's interest.

We have here a welcome departure from the usual style of text book writing, and if Botany is to be taught on these lines, we can hope to have rows of smiling faces in our lecture rooms in place of the dull and drowsy ones we often see. Mr. Brimble's may be thoroughly recommended as a reliable text-book.

P. Maheshwari.

Letters to the Editor

An Abnormal Behaviour of Some of The Flowers of *Tamarindus Indica*, Linn.

INTRODUCTION

While fixing up the flowers of *Tamarindus indica* Linn. (common tamarind plant) for studying the reproductive phases, at the Botany Laboratory, Calcutta University, sometime back, I came across some abnormal flowers as shown in the accompanying figures.

The flower of *T. indica* consists of two yellowish caducous boat-shaped bracts, a calyx of 4 sepals which are connate at the base and are articulated to the pedicels. Usually they are green in the bud stage but become yellowish white during anthesis. A corolla consisting of three petals is found, of which two are large and broad and the third small and narrow. The two large petals are placed opposite and decussate with the sepals while the third overlaps the posterior lobe of the calyx (Fig. 1). All the petals are pointed towards the posterior side in relation to the axis of the inflorescence. They are whitish yellow with red veins. There are three perfect stamens united at the base to about half the length of the filament and then they separate into three parts, each bearing a versatile anther. At the point of separation of the perfect stamens there are four minute narrow processes, each alternating with a filament. There are also two other processes like those described above and are situated opposite to the point of curvature of the united bundle of filaments (fig. 2). According to the observations of the previous workers these processes (which are altogether 6 in number) are staminodes. The ovary is monocarpellary as is the characteristic of the *Leguminosae.* It contains generally five to ten ovules and is bent slightly downwards. The style is bent along with the filaments. (Fig. 2).

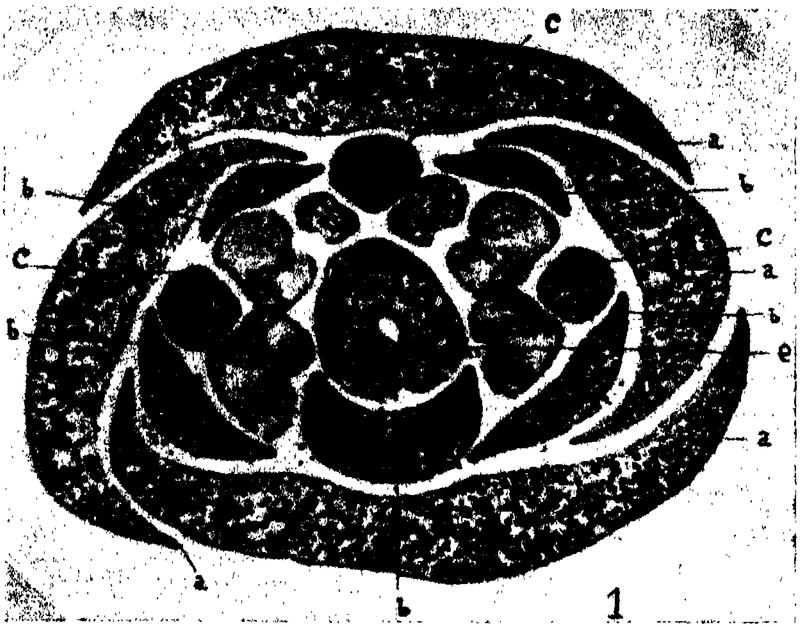

Fig. 1. Photo of a cross section of a flower bud of *T. indica*, showing five well developed petals in their respective positions. *a* = sepal; *b* = petal; *c* = stamen; e = Pistil.

The abnormality has been observed in the corolla of some flowers. The two lower processes referred to as mere "scales" or "Bristles" by previous workers have been found completely metamorphosed into petals. (Prain, Hooker, etc.). Thus 4 and 5 petals are noticed in most flowers. (Figs. 1. *a*, *b*, *c*, *e*. 3. *a*, *b*, *c*, *d*, *e*, and 4. *a*, *b*, *c*, *d*, *e*.). *a* = sepal; *b* = petal; *c* = stamen; *d* = staminodia; *e* = carpel.

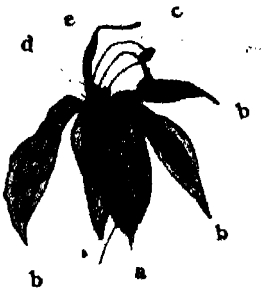

Fig. 2. A normal flower, showing the floral elements *a* = Sepal; *b* = Petal; *c* = Perfect Stamen; *d* = Staminodia; *e* = Ovary.

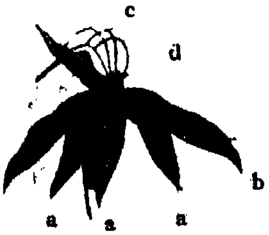

Fig. 3. An abnormal flower in which one lower process has reverted into a petal. *a*, *b*, *c*, *d*, *e* represent the same elements as in Fig. 1.

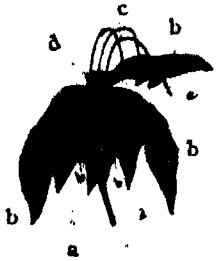

Fig. 4. An abnormal flower in which both the lower processes have reverted into petals. *a*, *b*, *c*, *d*, *e* represent the same floral elements as in Fig. 1.

DISCUSSION

All teratological observations are of especial interest to the botanists, from the point of view of right interpretation of various morphological questions which arise from time to time in the course of study. Some are of opinion that abnormalities give a clue to the right road towards an explanation especially when such is connected with floral parts. Thus Goebel[2] is of opinion that in many cases malformations give a deeper insight into the homologies of the reproductive organs in higher plants. A. St. Hilaire and Moquin Tandon[3] express that abnormalities are not due to merely freaks of nature caused by chance but may be referred to the common laws of organization. Very recently Bose,[1] while interpreting the abnormality observed in the flower of *Cucurbita pepo* L., came to the conclusion that "the real value of abnormalities lies mostly in the elucidation of otherwise obscure points such as the determination of affinity, homology, etc., of plants and their organs".

The primitive type of flower is assumed as hermaphrodite, regular and without any cohesion of parts. From this afterwards various diverse forms have gradually arisen with different modifications (Lawson, 5). The general plan of floral parts in *Leguminosae* is sepals 5 united, petals 5 free, stamens 10 free or united and pistil 1. In *Tamarindus*, as already mentioned they are 4 : 3 : 3 : 1, which should not be the case generally. Therefore the development of the two lower processes, into definite petals, so long described by other investigators as mere scales and Bristles or staminodes represent reduced petals which sometimes under favourable conditions show signs of "Reversion". The present interpretation also to some extent is in accordance with the general plan of organization of the floral elements in *Leguminosae*.

SUMMARY

A common form of abnormality found in the corolla of some flowers of *T. indica* L. has been noted for the first time. Thus 4 and 5 petals have been observed in many flowers. It has been suggested that it is a process of "Reversion".

Govt. Agt. Research Station, Dacca. A. K. Paul.

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Synthesis of 3 Nitro 4 Methyl Phenyl Napthyl Ketone

By the action of a hydrous Aluminium Choloride on a mixture of 3 Nitro 4 Methyl Benzoyl chloride and Napthalene in Carbon bisulphide in the cold, a 3 Nitro 4 Methyl

LETTERS TO THE EDITOR

Phenyl Napthyl Ketone has been obtained (M.P 91°c). It gives a picrate M.P 109°c and a hydrozene M.P 120°c. It is being investigated for an α or β Napthyl derivative.

Further work is in progress and the details of the work will be published in the *Journal of the Indian Chemical Society*.

In this connection, I desire to express my sincere thanks to Sir P. C. Ray to when I am indebted for kind encouragement and research facilities in his Laboratory.

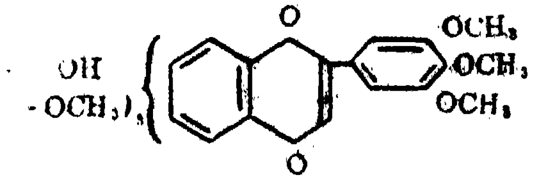
Sir Tarak Nath Palit Laboratory,
University College of Science
92, Upper Circular Road,
Calcutta.
17. 9. 36.

R. B. Chatterjee.

On the Constitution of Gardenin

From the resin of ***Gardenia lucida***, Roxb. known in India as Dikamali, Stenhuose and Groves[1] isolated a crystalline, bright yellow substance, m. p. 163-64°, to which the name *gardenin* was given. They assigned to it the formula $C_{14}H_{12}O_6$. M Rajendralal Nath, working in my laboratory, has isolated gardenin from the same source and has confirmed many of the reactions and properties of gardenin as reported by Stenhouse and Groves. His analytical data however differed, though slightly, from those of the previous investigators. Gardenin has been found to contain a high percentage of methoxyl. It formed a monoacetyl derivative, m. p. 116°, the molecular weight of which was 460.4. His analytical results best agree with the formula $C_{21}H_{22}O_9$ or $C_{15}H_3O_2$(OH) $(OCH_3)_6$.

Gardenin is optically inactive. It is soluble in hot dilute aqueous alkali with an orange colour. An alcoholic solution of gardenin turns green on the addition of ferric chloride, and deep red on reduction with magnesium and hydrochloric acid. It does not respond to the tests of quinones. Alkaline hydrolysis gave trimethyl gallic acid and a phenolic substance, m. p. 162°, the constitution of which has not yet been definitely settled. Gardenin is believed to be a flavone derivative, the partial formula of which is



It is resistant to aerial oxidation in presence of alkali which suggests that the -OH group is not in position 3 of the benzopyrone nucleus. He has morover shown tha the formation of "gardenic acid" of Stenhouse and Groves is accompanied by loss of a methyl group and that "gardenic acid" behaves like a quinone. Further work with a view to establish the constitution of the colouring matter is in progress.

University College of Science,
Calcutta,
16. 9. 36.

P. K. Bose.

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1 *Annalen*, 200, 311 (1880).

The Effect of Snake Venom on the action of Trypsin and pancreatic juice

It is well known that snake venom contains proteolytic enzymes. The optimum activity of the enzymes in the venoms of cobra and Russell's viper has been found by us to be at pH 8.0 - 8.2, using egg-albumin and gelatin as substrates. This suggests that the enzyme in these venoms is probably identical with trypsin. We next tried the effect of these venoms on the activity of trypsin (Merck's), to find out whether they contain any trypsin activator. It will be evident from the following data that they exert a marked inhibiting action on trypsin.

TABLE I.

Venom—Russell's Viper.

Substrate—Gelatin (5% solution).

The extent of digestion of gelatin in 24 hours as determined by Willistätter's method using 0.0448 *N* alcoholic KOH.

pH	Digested with 2 cc. of 1% venom.	Digested with 1 cc. of 0.1% trypsin.	Digested with 2 cc. of 1 % venom & 1 cc. of 0.1% trypsin.
7	1.28	10.08	3.28
7.6	1.76	10.8	3.60
8.5	1.68	9.84	3.04

TABLE II.

Venom—Cobra (Naja Naja)

Serength of alcoholic KOH—0.0412 *N*.

pH	Digested with 2 cc. of 1% venom for 24 hours.	Digested with 1cc. of 0.1% trypsin for 24 hours.	Digested with 2 cc. of 1 % venom & 1 cc. of 1.0% trypsin for 24 hours.
7	1.92	9.32	4.48
7.6	2.2	10.0	5.2
8.5	2.08	9.28	5.0

LETTERS TO THE EDITOR

Delezenne[1] found that addition of even a small quantity of snake venom markedly increased the proteolytic activity of inert pancreatic juice. He therefore concluded that the venoms used contain a kinase analogous to enterokinase. Delezenne's observation has recently been confirmed by Masakazu Sato and Tamotsu Hirono[2] working with glycerol extract of pancreas. It may be mentioned that Delezenne's observation can be accounted for even if there be no kinase in snake venom. Recently Northrop and co-workers[3] have shown that in inert pancreatic extract there is another proteolytic enzyme besides trypsinogen and this they termed chymotrypsinogen. They further showed that a trace of trypsin can convert inactive chymotrypsinogen to the active form chymotrypsin. Addition of snake venom (which we have already shown contains trypsin), to the pancreatic juice will convert chymotrypsinogen to the active form chymotrypsin. This would account for the increased proteolytic activity of the pancreatic juice as observed by Delezenne and Masakazu Sato. In our experiments we have used trypsin associated with chymotrypsin and not their inactive forms, hence addition of snake venom to these enzymes is not expected to bring about any increase in their proteolytic activity.

University College of Science & Technology.
Calcutta.
4. 9. 36.

B. N. Ghosh.
S. S. De.

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1. *Compt. rend*, *135*, 329, 1902.
2. Mem. Faculty Sci. Agr. Taihaku, *9*, 1935.
3. Kunitz, M and Narthrop, J. N. *Science*, *78*, 1933.

Chemical Examination of Water from *Cocos Nucifera*

It is well known that the water of the unripe fruit of the plant, *Cocos Nucifera*, commonly known in Bengal as 'Dâb,' is a fine cooling and refrigerant drink. It is also supposed to be an useful medicament in urinary disorders. As no special work[1] on the subject is being noticed, a systematic study of this valuable nutritive was found to be of considerable interest. But while the work was in progress, a note on the ascorbic acid content in cocoanut was recorded by Banerjee.[2]

In the present investigation the fruits, that have been used, were all taken from our garden at Baranagore. Three cocoanuts of a particular variety from each of the sixteen different plants were collected and the water of each fruit was examined for determining the volume present, the pH value, the percentages of sugar (both reducing and non-reducing) and salt, and the concentration of ascorbic acid.

Type of the fruit.	Volume of water in c. cs.	PH	Percentage of Reducing Sugar in gms.	Percentage of Non-reducing Sugar in gms.	Percentage of Salt in gms.	Mg. of Ascorbic Acid per c. cm. of water.
Green nut without any kernel	295	4.80	3.950	0.148	0.280	0.0250
Green nut with soft kernel (thickness varying from 0-4 mm).	230	4.90	5.250	0.329	0.252	0.0371
Green nut with semi-hard kernel (thickness varying from 2-6 mm).	235	4.88	5.256	0.484	0.268	0.0344
Brownish Green nut with hard kernel (thickness varying from 10-12 mm).	210	5.30	2.240	0.160	0.383	0.0224

In the above table the average result, from a study of forty-eight different samples of each variety of cocoanut, is recorded. The percentage of reducing sugar has been calculated in terms of glucose and that of the salt in terms of sodium chloride as most of the salt has been found to be present as chloride of sodium. Traces of potassium and magnesium chlorides have also been detected.

From the table it is evident that the quantity of water decreases where as the pH value increases with the growth of the fruit. The percentage of total sugar is found to be highest in the nut with semi-hard kernel. As the nut matures the sugar content of water considerably diminishes. The most interesting feature is the existence of a close relationship between the respective concentrations of sugar and ascorbic acid. Thus, when the water is richer in its sugar content, the ascorbic acid is also present in its higher concentration. Lastly, the salt is found to be in its lowest percentage, when the water of the fruit might be considered to be richest in its nutritive value.)

In conclusion, the author wishes to acknowledge his indebtedness to the authorities of the firm for allowing him to publish this note, and to express his sincere thanks to Dr. U. Basu for his keen interest in this investigation.

Research Laboratory,
Bengal Immunity.
Calcutta.
The 1st. Sept. 1936.

S. K. Ganguli.

1. C. G. Mathews, ***Analyst.*** 223. 1924,
2. Banerjee, SCIENCE AND CULTURE, *I*, 159, 1935, cf. also Biswas and Ghosh, *ibid*, page 518.

Preparation of a few Chlorocoumaro-α-Pyrones

The natural products bergapten and xanthotoxin have got some biochemical interest and as coumarin-coumarone structure has been assigned to them by Pomeranz and Thoms[1], it was worth-while to prepare coumarin-coumarone compounds starting from the chlorocoumaro-α-pyrones by hydrolysis and subsequent distillation with lime.

With this object in view the preparation of the following chloro-coumaro-α-pyrones has been taken up.

1. 3-chloro-4-methyl-coumaro-7: 6 (or 7 : 8)-α-pyrone

3-chloro-4-methylumbelliferone[2] (5g) was intimately mixed with malic acid (5g) and 15 c. c. sulphuric acid (d. 1. 84) were added to the mixture. The mixture is heated on the waterbath in a flask, provided with a calcium-chloride tube at the neck of the flask. Effervescence soon begins and the solution becomes deep red. It is heated for about 4 hours when the effervescence practically ceases. The contents of the flask are poured on ice and a precipitate is obtained. It is filtered and the precipitate is digested with ammonia to remove any unchanged 3-chloro-4-methyl umbelliferone. It is recrystallised from glacial acetic acid in brown plates, m. p. 265-266°C. Yield about 30%. It is insoluble in ammonia and sodium carbonate solution but soluble in hot caustic alkalis—producing first yellow, then deep red solution. Found Cl 13. 18% ; $C_{12}H_7O_4Cl$ requires
Cl 13. 52%.

2. 7-methyl-3-chloro-4-methylcoumaro-5 :8 -α-pyrone.

An intimate mixture of 3-chloro-4-methyl homoumbelliferone[3] (5g), malic acid (5g) and concentrated sulphuric acid 15 c. c (d 1.84) was heated on the waterbath for aboutt hree hours till there was no more effervescence. It was then poured on ice and the precipitate obtained was digested with ammonia and finally recrystallised from glacial acetic acid in prismatic needles, m. p. 288°C. Yield about 20%. Found Cl 12 % ; $C_{13}H_9O_4Cl$ requires Cl 12.83 %.

3. The condensation of 3-chloro-4-methyl-5 :7-dihydroxy coumarin with malic acid :

3-chloro-4-methyl-5:7-dihydroxycoumarin[4] (15g) malic acid (15g) and sulphuric acid 40 c. c. (d 1.84) are heated together on the waterbath for 5 hours. It is then poured on ice and the crude condensation product obtained as usual. The crude product is repeatedly extracted with absolute alcohol till the filtrate becomes almost colourless. Yield about 60%. Recrystallised from pyridine it melts at 312 - 313°C with decomposition.

Found Cl 12.23%, $C_{12}H_7O_4Cl$ requires
Cl 12.75%.

4. 8-hydroxy-3-chloro 4-methyl-coumaro-7:6-α-pyrone :—

3-chloro-4-methyldaphnetin (20 g), malic acid (15g) and con. sulphuric acid (d 1.84) 40 c. c. were heated together on the water-bath for 5 hours. It was then poured on ice, filtered—and the mass obtained was repeatedly digested with absolute alcohol. It was recrystallised from pyridine in colourless shining plates. It shrinks at about 310° and does not melt even at 325°C.

Found Cl 12.77%, $C_{12}H_7O_4Cl$ requires Cl 12.75%. Further work in the line is under contemplation.

Biochemical Laboratory,
Bengal Chemical & Pharmaceutical Works Ld.
Calcutta, 26th August 1936.

H. G. Biswas.

1. *M.* ***12***, 379
   M. ***14***, 28
   B. ***44***, 3325
   B. ***45***, 3705.
2. *B.* ***34***, 354
3. *B.* ***42***, 901
4. *B.* ***42***, 901

SCIENCE AND CULTURE

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The Problem of Nitrogen Supply to the Indian Soil

A SYMPOSIUM on the above subject was held in Calcutta on the 29th and 30th August at the Royal Asiatic Society of Bengal under the auspices of the National Institute of Sciences of India. Nineteen papers were contributed from different parts of India and Burma representing various aspects of the problem. The symposium was presided over by Brigadier H. J. Couchman, D.S.O.,M.C., President of the National Institute of Sciences. It is well known that Indian soils have low nitrogen and carbon contents. The Royal Commission on Agriculture emphasized the importance of a concerted attack on this problem for a satisfactory scientific solution. In fact, remedies for these deficiencies form one of the major issues the solution of which will be of the greatest benefit to India agriculture. Symposia and conferences of scientific workers serve the very useful purpose, namely, that they afford an opportunity to workers on a particular branch of science, who are scattered over the country, to meet and discuss scientific matters of common interest and exchange views untrammelled by other attractions. The co-operation of workers in different branches of science is called for in the solution of agricultural problems. The National Institute of Sciences, being the central co-ordinating body in scientific matters, is rendering a very useful service by holding such symposia at their meetings. The symposium was organized by Prof. J. N. Mukherjee at the request of the Council of the National Institute of Sciences at Indore. Papers for reading at the symposium were contributed by Prof. N. R. Dhar and his co-workers (Allahabad), Dr G. Gopala Rao and Mr K. S. Murty (Waltair), Rao Bahadur D. L. Sahasrabuddhe (Poona), Rao Bahadur B. Viswanath (Delhi), Mr D. V. Bal (Nagpur) Prof. V. Subrahmanyan and his co-workers (Bangalore), Messrs K. M. Pandalai (Bangalore), T. J. Mirchandani (Sabaur), P. K. De (Dacca), G. B. Pal and S. C. Rakshit (Dacca), Dr A. T. Sen (Dacca), Messrs H. N. Pal (Assam), S. P. Aiyar (Mandalay), and Y. D. Wad and R. K. Aurangabadkar (Indore). Among others who also attended the meeting and joined in the discussion which followed the reading of the papers were Prof. J. C. Ghosh (Dacca) and Dr H. Chaudhury (Lahore).

In spite of the deficiencies in organic matter and soil nitrogen, soils which have not been treated with manures have in many instances continued to maintain an average yield of crops. The soil may derive its nitrogen from natural processes, such as fixation of atmospheric nitrogen by bacterial agencies. Besides, nitrogen may be added to the soil through manures. There are also various sources of losses of nitrogen. The loss and recuperation of nitrogen in soils, the supply of nitrogen to the crops in accordance with their needs, the dependence of the total and available nitrogen in soils in the climatic factors, such as rainfall and temperature, and various other aspects have been covered by the contributions to the symposium.

The part played by bacterial agencies in the recuperation of soil nitrogen is well established. In recent years Prof. Dhar has suggested that in tropical soils, especially under ærobic conditions, photosynthesis and photocatalysis also play an important part. Bacteria derive their energy necessary for the fixation of nitrogen from the oxidation of carbonaceous matter. Prof. Dhar suggests that the energy liberated by photochemical oxidation can bring about the fixation of nitrogen in the presence of suitable catalysts independent of bacterial action. He has reported experiments in the laboratory, showing that sterilized soil can act as a photocatalyst in the presence of an easily oxidizable carbohydrate, *e.g.*, glucose in inducing nitrogen fixation. A point of immediate practical importance hinges on this investigation. The rapid development of the sugar industry in India which has resulted from the protection afforded to it by the legislature has brought in its train the difficulties of a proper disposal of the molasses and the utilization of the bagasse. Prof. Dhar has shown that the molasses can be substituted in the field for the glucose in the laboratory experiments for increasing the nitrogen content of the soil. Besides helping the fixation nitrogen, the presence of the carbohydrate retards the loss of nitrogen by the oxidation process. Molasses, in addition, contain other constituents, *e.g.*, potash, phosphoric acid, and lime which are to be looked for in a desirable fertilizer. The utilization of molasses for increasing the productivity of the soil thus affords a happy solution of the difficulty. Using 3 tons of molasses (price Rs 20/-) per acre of land Prof. Dhar and his coworkers obtained a fixation of 112 lbs of nitrogen (worth Rs 55/-) from the atmosphere. Their experiments also show that the oxidation products of molasses which are acidic in nature are helpful in ameliorating the alkaline soils in the United Provinces. Mr Mirchandani by his observation in Bihar soils has confirmed the usefulness of molasses in increasing the nitrogen contents of soils and in reclaiming alkaline soil. Regarding the amelioration of alkaline lands, he, however, expressed doubt as to the permanency of the results. Prof. Dhar mentioned in the symposium that the Mysore Government, by applying one ton of molasses per acre, had obtained the yield of 1200—1800 lbs of rice grains per acre from alkaline land where the crops failed completely in previous years. The yield is comparable to the average yield of normal Indian soils.

The observations of Rao Bahadur Sahasrabuddhe on the other hand tend to show that bacterial rather than photochemical action is mainly responsible for the nitrogen recuperation of soils. His experiments with Poona soils show that the magnitude of the fixation depends upon moisture and temperature, but not upon the intensity of light. The addition of $CaCO_3$, phosphates and organic matter to soils deficient in these constituents improves the recuperating power.

Rice soils and even rice plants have been found to possess nitrogen-fixing power. Rao Bahadur Sahasrabuddhe found that the nitrogen-fixing power increases in presence of growing rice roots. Dr A. T. Sen and Mr P. K. De consider algæ to be responsible for the fixation of nitrogen in rice soils, but it is not clear from the experiments whether they do so alone or in symbiosis with other organisms. Nitrogen-fixing organisms have been found also in rice leaves. Dr H. Chaudhury has mentioned during the discussion that in the culture experiments carried out by himself on sample of soil from Eastern Bengal algæ were found which contained nitrifying bacteria in their mucilage coatings. These bacteria could fix nitrogen in neutral or slightly alkaline media. We learn that Mr De has been enabled by the Imperial Council of Agricultural Research to prosecute a detailed investigation on the algæ in rice soils in the laboratory of Prof. Fritsch.

Mr D. V. Bal has also come to the conclusion that black cotton soil possesses considerable nitrogen-fixing power. Pot culture experiments conducted for nine years showed a resultant increase of nitrogen content while in the field the soil did not show deterioration of organic nitrogen after growing wheat continuously for nine years. Legumes grown with wheat do not definitely improve the nitrogen status of these soils.

Mr. Vaskaran and Prof. Subrahmanyan and Mr Pandalai have investigated the non-symbiotic activity of nitrifying organisms. A pure strain of azotobacter decomposes sugar without nitrification while that of nitrosomonas is paralysed by its presence. But a mixed culture, such as the mixed flora, existing in the soil, has considerable nitrogen-fixing power. The residual decomposition product of the carbohydrate and not the carbohydrate itself is helpful in the growth of these soil organisms and in the nitrification process.

The possible mechanism of the nitrogen transformations in the soil and its loss were discussed in a number of communications. According to Prof. Dhar, the processes of ammonification and nitrification are photocatalytic in nature. This view is supported by the observations of Dr Gopala Rao. Ammonium nitrite is formed during the process which decomposes in the high tropical temperature and the nitrogen is lost in the elemental form. Easily oxidizable carbonaceous substances retard both ammonification and nitrification and thus help to conserve soil nitrogen. Prof. Subrahmanyan on the other hand holds that in swamp soil the rate of ammonification is higher than that of nitrification and the free ammonia which thus accumulates is lost by volatilization. The loss varies in the opposite sense with the C:N ratio. The addition of carbonaceous substances diminishes the loss of nitrogen by increasing this ratio. The experiments of Rao Bahadur Viswanath at Coimbatore show that the loss of nitrogen is dificult to explain on the basis of current theories. "Photochemical action can explain the fixed losses but there must be some other factor." Mr De concludes that in water-logged soils the supply of oxygen, being limited ammonia, is oxidized first to hydroxylamine and then to gaseous nitrogen. The loss by the decomposition of ammonium nitrite is not considered likely and in these regards a viewpoint different in some respects from that of Prof. Dhar has been mooted.

The problem of nitrogenous manures in its various aspects has received considerable attention. On comparing green manure, cattle manure, and artificials, Rao Bahadur Viswanath has observed the addition of nitrogen to the soil by fixation on the application of green and cattle manures. Mr Mirchandani has also observed a beneficial effect on combining organics with artificial manures. The dependence of the loss of nitrogen on the C:N ratio and its importance in manuring has been stressed by Rao Bahadur Viswanath, Mr Mirchandani, and Prof. Subrahmanyan.

Messrs Wad and Aurangabadkar have found that in the soils of Bundelkhand, Malwa, and Rajputana the application of nitrogenous manure does not produce any response in the crop yield. Mr Aiyar working with Burma soils has found that nitrogen added in the form of ammonium sulphate is most effective in increasing the yield of paddy and the results improve on combining it with phosphate. Nitrates, ammonium carbonate or calcium cyanamide are less effective. Green manures and organisms which liberate ammonia in the field have been found to increase the yield markedly. But he considers that there appears to exist a limit beyond which the yield of paddy in tropical soils cannot be increased whatever be the treatment and thus expresses a doubt as to the possibility of attaining the yields obtained in temperate climates.

In discussing the proper time for the application of oil cakes for quick-growing crops in relation to current agricultural practice in East Bengal, Messrs Pal and Rakshit have recommended its application in the *Rabi* rather than in the *Kharif* season, as otherwise the nitrates formed from the oil cakes are easily washed away during the monsoon rains. In the case of rice crops Dr Sen has recommended the application of manure at such a time that the available nitrogen status may be increased during the active vegetative growth and the beginning of the flowering stage.

Prof. Subrahmanyan and Dr Sreenivasan have pointed out that considerable errors may arise in the sampling of soils due to their nonhomogeneity. The periodic variations in soil nitrogen observed by various workers might have been vitiated due to this factor. Mr Pandalai described a method of determination of nitrous acid in soils by oxidation with hydrogen peroxide. Mr Rajagopalan also described his experiments carried out with Mr Iyer and Prof. Subrahmanyan on what has been claimed to be a quick and accurate method of determination of nitrogen in soils.

A systematic study of the types of soils existing in different parts of India in relation with the climatic factors, such as temperature and rainfall, and with their productivity is very much to be desired. It is therefore gratifying to note that investigations on these lines have been carried out by Mr Aiyar on Burma soils and by Messrs Wad and Aurangabadkar on soils of Bundelkhand, Malwa, and Rajputana. Mr Aiyar has been able to show that the variations of soil nitrogen with temperature and rainfall follow Jenny's law, *viz.*, that it increases with lowering of temperature and with increase in rainfall. The observations of Messrs Wad and Aurangabadkar show the absence of any relation between the nitrogen content of the soil or the C:N ratio and the climatic factors. Even the productivity of the soil is not always dependent on the nitrogen content. But it is concluded from a study of soil samples at different depths of the soil profile that similarity in the maintenance of the carbon and nitrogen contents in the first two horizons is mainly responsible for the fertility of the soil.

We congratulate the authorities of the National Institute of Sciences for having organized this very useful discussion.

On the Conservation of Indian Coal

S. K. Ray

Professor, Indian School of Mines, Dhanbad.

In the Quinquennial Review of the mineral production of India published by the Geological Survey, 1928, Dr C. S. Fox (p. 71) puts the coal reserve of India at about 54,000 million tons. Now, it is well known that, even with the most systematic working, at least 1/3 of the coal has generally to be given up for loss due to inaccessibility, or due to its occurrence at dangerous places, unless sand-stowing was done. The actual waste of coal that we are going to face in our Indian mines is much more: perhaps 65% of our total coal reserve. On account of the faulty methods of mining that prevailed until recently, many coal seams caught fire and many are still catching fire in the old workings, and the fire will go on eating up the coal for years and years if no remedy is discovered. Then again, being not sand-stowed, the coal seams get goaved[1], and consequently water-logged, in their upper portions. In this way it is gradually getting more and more difficult, uneconomical, and risky to work in the deeper portions of the seams. There the miner always stands the risk of being flooded by water accumulated in the upper areas which have not been sand-stowed or his whole enterprise might one morning be turned into smoke by the sudden appearance of fire. The situation is being aggravated by the fact that better coals, usually of rare varieties suitable for metallurgical purposes, sometimes occurring below the II class coal, are now-a-days being extracted and used up in huge quantities for boiler firing, etc. They are consumed for purposes for which they should not be used. After their extraction the whole of the upper layers of rocks, together with millions of tons of II class coal, quite suitable for boiler heating and domestic purposes, is allowed to go down into goaf consisting of a hopeless mess of rock and coal debris from which there is never any chance of an economical extraction of coal. Thus, not only is a large quantity of coal occurring at the deeper regions of the mine faced with the danger of abandonment on account of fire, inundation, and the present-day methods of unrestricted working, but many coal seams occurring near the surface are also being ruined.

What I have tried to explain above has not been said here for the first time. Many British mining engineers have already protested very strongly against the reckless methods of working of the coal mines of India leading to a huge and deplorable waste of the natural riches of our country.

Mr B. Starks Field, Agent of Messrs Bird & Co's collieries, reviews the loss of many very valuable coal seams of India, due to robbing of the first class coal from underneath, in the following way: 'With regard to the conservation of coal and the Grading Board, it so happens that in the Jharia Coal-field there are certain thick seams of which only a part of the section has been graded as "selected", or "first class". Now many companies cannot dispose of anything inferior to at least "first class" graded coal at the present day, so they have no alternative but to work only the better-graded section of these seams, and leave the rest, which in some cases amounts to 60 per cent of the total coal in seam; this portion, in one particular instance, being in the upper part of the section, is entirely lost to posterity, when the lower and better part of the seam is goaved. The top portion, although not graded as "selected" or "first class", falls just slightly under the Grading Board's requirements for "first class" and is, therefore, a very valuable coal which may some day be wanted.

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[1] Goaving means subsidence of the rocks occurring above the coal seams due to the extraction of coal. By this all the rocks, up to surface, are usually affected. The area becomes full of cracks and suitable for accumulation of water.

"There are other cases where a lower seam has been graded as "selected", while a thick seam above, which was one of the favourite seams in the Jharia Coal-field before the days of the Garding Board and has been extensively worked in the first working, falls just below the Grading Board's requirements for first class coal; yet this obviously valuable coal is being ruthlessly wasted by the goaving of the seams below.'[1]

Following are the remarks of Mr Farquhar on the waste of the coal reserve of India: 'That reckless methods have been in operation ever since the commencement of coal mining in India is well known to mining engineers, but the extent to which it has gone is only known to a few who made a special study of the problem. The consequences are now apparent in the subsidences and other disasters which occasionally thrust themselves on the public notice, but a more serious phase of the matter which the laymen do not get to know is the more difficult and dangerous conditions that have resulted in collieries which have been exploited in such a manner. Even if large reserves of coal have not been irretrievably lost the methods of present or future recovery are bound to become more dangerous and expensive, and this is undoubtedly reflected in the increased accident rate and raising costs as compared with twelve years ago[2]".

In his paper, "The future of the Jharia Coal-Field", Mr R. R. Simpson, C. I. E., the retired Chief Inspector of Mines in India, condemns the wastage in the following terms: 'Where the *coal* seams are close together or at a depth exceeding 300 feet the loss of coal by collapse of pillars and spontaneous fires has been great'. Elsewhere he remarks (p.113): 'Year by year the areas of workings lost on account of collapses and fires are extending.... The Jharia Coal-field is our only storehouse of importance *for metallurgical coal*.... If not *sand-stowed* the future of Jharia Coal-fields is gloomy indeed...... Some of the deeper mines have already been closed owing to the prohibitive cost of pumping. The loss of fully one half of the coal will be inevitable'.[1]

Hence even at the present ridiculously low price of Indian coals averaging at about Rs 3/8 per ton, India is going to lose thousands of crores of rupees worth of coal if she does not compel her mining proprietors to sand-stow their mines.

Sand-stowing would make the coal expensive. Mr Farquhar puts the sand-stowing expense approximately at Rs 1/3 per ton of coal.[2] If I remember correctly, some time ago Messrs Mackie and Simpson, suggested that if done on a large scale the cost might come down to even -/8/- per ton of coal. To avoid unfair competition it is necessary that sand-stowing should be made compulsory to every mine of first class or selected grade coal. Considering that about 2 lbs of coal are consumed now-a-days in the modern boilers to generate 1 h. p., even an increase of about a rupee per ton in the fuel bill of the industry is a very small amount. But, on the other hand, the country will save many crores of rupees, the purchasing power of India will go up, and other industries will profit considerably, if coal, a great natural wealth of India, is saved.

Some time ago, Mr John Henry pointed out: 'The working of great coal seams of this country has resulted in a confessedly immense wastage, almost unparalleled elsewhere. This wastage, whatever be the cause, is a scandal for which the present generation will ultimately be called to account....'(*Transactions of the Mining & Geological Institute of India*, Vol. XXIV' pp. 119-120). No human being has any right to waste any natural riches and it is all the more a Government's duty to safeguard them'. (C. Forrester, *Loc. cit.* p.120). All well-wishers of India, specially the geologists and mining engineers who are intimately connected with mineral industry of our country, should realize the danger, explain it properly to the Government and urge them to introduce a law prohibiting this waste of national wealth.

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[1] Simpson, R. R.—"The future of Jharia Coal-field", —*Trans. Min. and Geol Inst. of India*, Vol. XXIV, 1929, pp. 117-118.

[2] "Some notes on present conditions in the coal-fields with reference to legislation and education", *Transactions of the Association of Colliery Managers in India*, Vol. XVI, 1929-30, p. 40.

[1] *Loc. cit* pp. 110-146. Italics mine.

[2] Farquhar, A.—"Sand-stowing in Bhowrab Colliery"; *Trans. Min & Geol. Inst. of India*, Vol. XXVI, 1931, p. 79.

Suggestions have often been made that India's coal reserve is almost inexhaustible.[1] This, in my opinion, is not quite correct. At the back of these suggestions lay the idea that the consumption of coal in India would *in future remain stationary at the* present figure.

From the graph given on p. 235 which represents the amounts of coal raised in India during the last 50 years (1880 to 1930 ; *Rec. G. S. I.* & Mr F. L. G. Simpson's presidential address, Mining & Geological Institute of India, 1929) it will be seen that since 1890 the output has continuously increased. There are some minor discrepancies, as in 1918, but this was due to exciting conditions prevailing all over the world on account of the War. This over-rapid production had a natural collapse and the output came back to the regular curve in the following years and increased gradually along the curve.

India is still at the infancy of her industrial development. In the words of Sir C. V. Raman, "She (India) has to depend for everything except her food resources on the industries of the other parts of the world. As an industrial country she is still an infant. The years to come will be years of economic reconstruction of India". Coal is necessary for every industry. At the present moment only a small fraction of the total need of the country in iron goods, piece goods, copper goods, etc., all of which consume huge amounts of coal for their manufacture, is produced in India. Though India probably possesses the finest iron ore deposits of the world, conveniently situated near her coal and manganese mines, she still imports in average 50 crores of rupees worth of *iron and steel materials* annually (*Rec. G. S. I.*, Vol. LXIV, p.145). In 1924 she imported 982,000 tons and in 1926, 998,000 tons of steel and steel products while she herself produced 240,000 and 360,000 tons respectively in these years. (Mr T. K. Nair, presidential address, the Geol. Ming. & Metallurgical Society of India, 1928). She imports about 4 crores of rupees worth of copper and brass and smelts on an average only about 20,000 tons, worth about Rs 40 lakhs, though her reserves are fairly big. She imports even 79 lakhs worth of coal and other fuels. There is thus in this country an enormous scope for industrial development, and it will still take many years before the graph becomes a horizontal line showing more or less *a constant amount of coal being raised during* successive decades.

Thus, assuming a steady development of the industrial and economic condition of India, and peace and tranquillity reigning in the Empire during her evolution, the coal consumption, according to the curve, *reaches the 100 million tons level in 2025, i. e.* about 100 years hence. This might appear rather too much, but this sort of increase in a fairly short period is nothing extraordinary for a country with 1/5 of the population of the earth. A comparison with the United States of America may be instructive. In 1890 U. S. A. mined 141 million tons of coal, in 1912 her total coal production was about 477 million tons, and in 1922, 554 million tons. That is, her coal production increased by about 4 times in the course of about 30 years. (Dannenberg, *Geologie der Steinkohlenlage* Part II, pp. 1 and 10 & Spurr & Wormser, *Marketing of Minerals*, Chapter on coal). It is therefore not improbable that India may mine 5 times its present output of coal a century hence, and at that rate the coal reserves of India will only last another 200 years.

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[1] (*a*) "The quantity of coal usually described as II class is practically inexhaustible and can be calculated in thousands of million of tons... At the present rate of output there is not more than 100 years' supply of first class coal available at a moderate depth".—V. Ball & R. R. Simpson, ***Memoir** G. S. I.* Vol. XLI, p.48.

(*b*) "In the recently proved portions of the Jharia and Ranigunj fields and in the Bokaro and Koranpur fields, there is at least 300 years' supply of good quality of coal available".—J. C. Brown, "Indian coal problem". ***Bulletin of Indian Industries & Labour***, No. 36, p.13.

(*c*) "Only 2% of the coal contained in the Jharia Coal-field has been exhausted up to the present. Allowing a big margin, it will be seen that well over 90% of the coal in the Jharia Coal-field is still embedded in the earth ..I think that there is still a long future in front of the coal industry in Jharia".—Dr. D. D. Penman, ***Transactions. Mining & Geological Institute of India.*** Vol. XXIV, 1929.

This is only one aspect of coal economy. There is still another phase of it, more vitally important to the Indian *nation*. The *iron ore* reserve of India is about 3,000 million tons (Nair), 1,768 million tons (Pascoe), and 3,948 million tons (Fox)[1]. Now, three tons of coking coal produces $2\frac{1}{4}$ tons of coke and about 1 ton of coke is necessary for the metallurgy of *one ton of iron ore*. Therefore, whichever of the above figures may be taken into consideration, it is quite clear that the cooking coal reserve of India is insufficient.[2]

We possess a fine tradition of iron metallurgy and have in our country the finest iron and manganese ore deposits of the world within easy reach of metallurgical coal. Under proper guidance India, which produced *the famous Asoka pillar and once* supplied most of the steel for the Damask blades, can again put herself in the forefront of the iron-producing countries of the world. If U. S. A. can produce 40 million tons of iron per year there is no reason why India also *cannot do the same.*

But before we reach the status of an important iron-producing country, we shall have to see that our insufficient coking coal reserve does not die out. This coking coal, like coal in general, is getting the same step-motherly treatment in the hands of the present-day mining industry. Most of the 20 to 22 million tons of coal that India is mining now-a-days is her metallurgical coal. Except a very small part of it, the rest is all burnt in locomotives and boilers, although it has been mentioned so many times that "the supplies of the first class coking coal are insufficient for the future requirements of the iron and steel *industry*" of India.[3] *If*, following Nair & Pascoe, the total coking coal reserve of India is taken to be near 1,000 million tons, and only half of it were procurable, then even in near future there would be a scarcity of metallurgical coal in India.

According to Brown (*Indian Coal Problem*, p. 13), "There is enough coking coal in India to supply the iron industry with *4 million* of tons of metallurgical coke per annum for the next 150 years at least". His calculation is based in the first instance on Sir Edwin's figures for the total quantity of metallurgical coal in India. But his estimate of 150 years differs from mine because the consumption of metallurgical coal is going on not at the rate of 4 million tons, but at the rate of about 20 million tons a year and is likely to increase in later years. As a matter of fact, even neglecting the progressive increase of consumption, as pointed out by me, and taking the future rate of consumption at the present actual figure of 20 million tons only a year, Brown's estimate of the life of metallurgical coal reduces to only 30 years.

Time will come, as Sir E. H. Pascoe predicts, when India will be sufficiently developed industrially, to capture a considerable part of the world market of iron. But it may be that by that time we shall find ourselves in a hopeless situation with regard to coal. Our iron ores will be useless if we do not import coal from outside. Immediate attempts should therefore be made to preserve at least the metallurgical coals of India.

Indian legislators are doing their utmost to preserve and encourage the iron and steel industry of India. The steel industry is receiving handsome bounties, it is protected by means of a tariff wall and recently it has been given even a higher price. Exactly similar favours are necessary for India's coking coal. *But nothing is done to protect it* although the steel industry is vitally related to and solely dependent upon coal. No one in the Legislative Assembly seems to realize that India's coking coal reserve is going to vanish perhaps within our lifetime, and all the capital involved in steel industry and all the money spent on account of its bounty, etc., will be absolutely useless if metallurgical coke is not conserved in the country.

It is not easy to suggest a clearcut remedy. But one or other of the following may probably be found suitable:

(1). The coal mines, especially those of metallurgical coal, may be nationalized. In addition to the usual economic working of the mines by the State, it may open a new department called "Coal Issue Board" similar to "Coal Grading Board" to whom the public may submit specification of their necessity and the Issue Board will despatch only that coal which in their opinion may be considered suitable to meet the requirements of the party.

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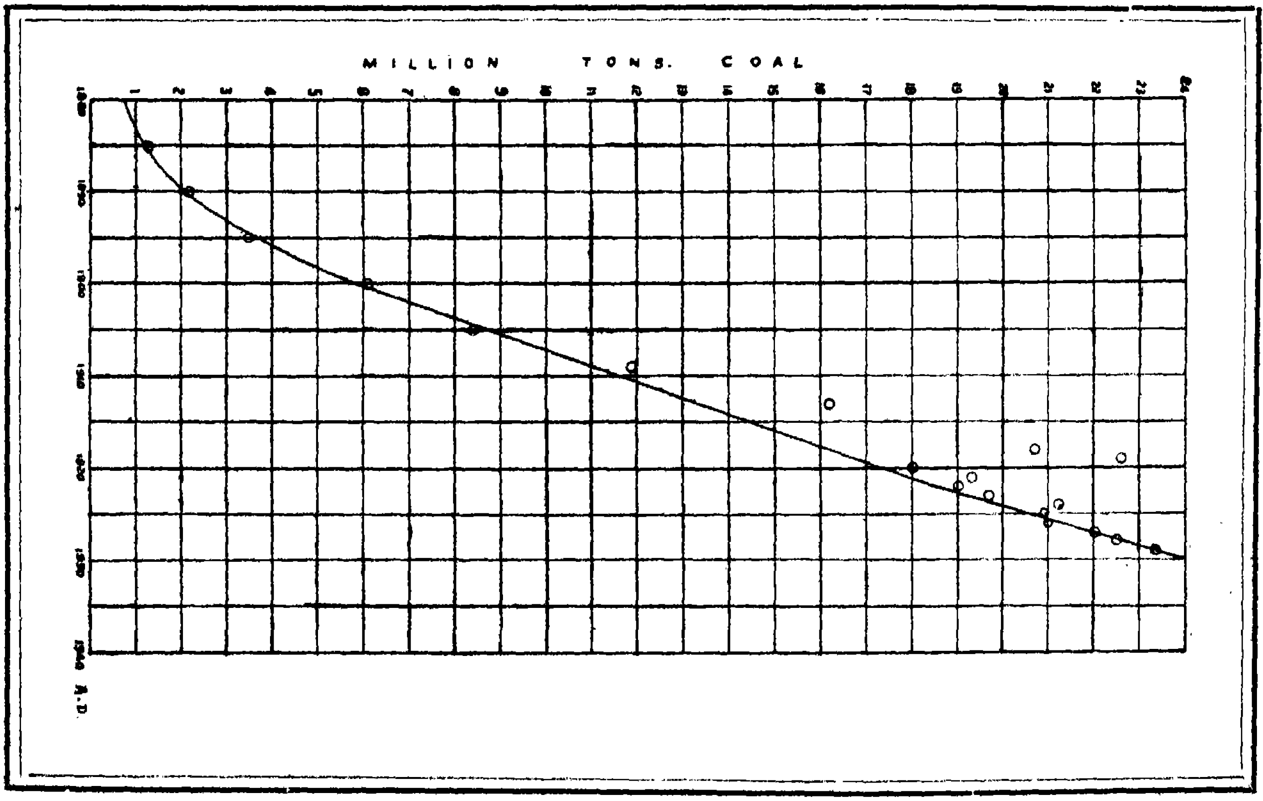
[1] A. T. Nair, 1542 million tons, *Loc. cit.* p. 123
Sir E. H. Pascoe, 1768 million tons, *Indian coal problem*, p. 13
C. S. Fox, 3948 million tons, *Rec. G.S.I.* Vol. LXIV, p. 71.

[2] & [3] "Indian coal statistics", Supplement to the *Indian Trade Journal*, Dec. 4, 1930.

(2). The metallurgical coal may be sold to the public at a price of 1 or 2 rupees above that of the ordinary steam coal and the higher price so realized could be spent under some sort of Government supervision for san l-stowing.

GRAPH



(3). The Government may not use metallurgical coal for firing locomotives and boilers.

(4). A bounty may be granted for sand-stowing and for similar economical working of mines.

These procedures might stop the present policy of killing the hen laying golden egg; because, it may tend to decrease the sale of metallurgical coal and increase the life of Indian mines.*

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* Read before the Geological. Mining & Metallurgical Society of India on the 28th August, 1931.

Illumination—Past and Present

(Continued from the last issue)

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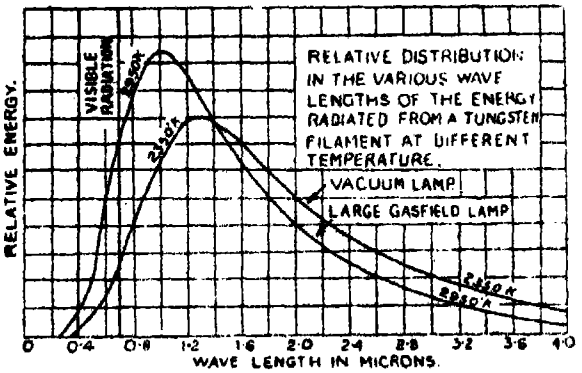
TANTALUM has a melting point near about 3000°K. Moreover its resistance increases with temperature so that while hot it has a higher resistance than when cold, a property which is of great use in increasing the steady value of luminosity. Though in 1905 tantalum lamp was brought into the market, it was soon found that it had another competitor. This was tungsten. Tungsten is a very important metal. Its wonderful properties in imparting hardness to steel were already well known, but to secure fine threads such as what could be used as filament was never realized till Bolton showed the way. Now several million miles of wire of tungsten have been drawn by strongly heating tungsten oxide in hydrogen atmosphere and pressing it in hot condition and drawing through saphire dies to the desired thinness of the wire. Tungsten wire has a melting point near about 3300°K and it could easily be heated to incandescence at a temperature near about 2500°K. The curve showing the luminosity and temperature is shown in the picture (figs. 2, 3, 4). Tungsten wire gradually increased the light output of a lamp from 3 lumens per watt to about 8 lumens in an ordinary vacuum globe.

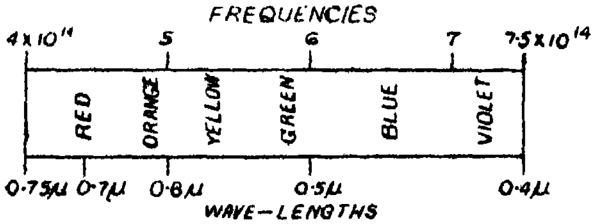
It was, however, found that a large portion of the energy generated in the filament was being wasted away in the vacuum enclosure and soon a limit is reached. The temperature of the filament could be raised up to 2350°K without shortening the life of the lamp. This results in a definite lumen value. The first attempt to increase the luminosity is due to the theoretical work of I. Langmuir who introduced the rare gas argon in the bulb and these inert gas molecules served by the pressure on the filament to keep down the heat dissipation to a large extent, but his gas-filling naturally had a cooling effect on the filaments as they are disposed of in zigzag fashion. He suggested the concentration of the filament in the form of a spiral, and thus we have now got the so-called gas-filled lamp. From an output of 8 lumens per watt it has now been possible to reach an overall efficiency of 11 lumens per watt. But the progress in this line has been further achieved by spiralizing the spirals and we have now got the so-called coiled-coil lamps, of about 13 lumens per watt. This has been secured by further concentration at the hot filament and further stopping the dissipation of heat and in increasing the efficiency. We have now reached practically to the present state of incandescent bulb lighting. Besides the bulbs of the usual pear shape, from the tiny headlight of a motor car to that of a torch, bulbs have now been constructed capable of withstanding a wattage of 15,000 so that in point of brilliance and surface of glow it has become a fair rival to the arc lamp for large-area illumination. Besides, the shapes of the lamps have undergone various modifications for decorating purposes. The architectural lamps are now gradually getting more and more into prominence in which the lamps are bent into various forms and shapes and behave like luminous rods to fit the general decoration of public buildings and even residential quarters. Thus far we have come to the end of our tale so far as incandescent lighting is concerned. Its main defect even in its most efficient form is that along with the light more than 70% of its energy is transformed into heat which is wasted from the lighting point of view. Some device, therefore, of illumination with more of light and less of heat would naturally be more desirable.

In the early seventies of the last century Hitoff and Plücker noticed that electric discharge of sufficiently high voltage could pass through tubes if gas inside such tubes were in a rarefied condition. Their glassblower Geissler produced curious fantastic tubes of various types and of coloured glasses through which the discharge at high potential produced beautiful colour effects. For a long time Geissler tubes remained mere scientific curiosities for the purpose of illumination though several attempts were made to utilize this property. The first successful attempt was that of Moore. He produced tubes containing a mixture of carbon dioxide and nitrogen and with a suitable transformer excited these tubes so that a reddish-white glow was emitted by them. These Moore tubes were used for nearly eight years in the different cities of America, till the time of the World War when they fell into disfavour due to the fact that their life was inconstant and the high voltage was more liable to be misused leading to accidents. The next tube in which rarefied gas was employed was due to Claude. Claude in 1919 first introduced rarefied neon-gas in tubes of different dimensions and thus started the so-called display tube industry all over the world. During the last sixteen years it has spread practically all over the world and the red glow of the neon tubes and the green and blue glow of other gaseous mixtures have been gradually finding place in advertisements and displays of different types. Apart from the pleasing effects of this type of illumination its use has been extended to the different air ports of the world as this red light is more distinctly visible through fogs and smokes which a modern city has as its natural concomitant. Thus the high voltage of about 3,000 volts is sufficient to excite these tubes and the watt consumed is much less than that of an incandescent lamp of the same range of luminosity. A recent development regarding these tubes is the introduction of substances inside which would fluoresce on being exposed to the light of the emission in the tube, thus adding further to the luminosity. These phosphor-tubes of variegated colour are gradually being introduced in high voltage discharge lamps.



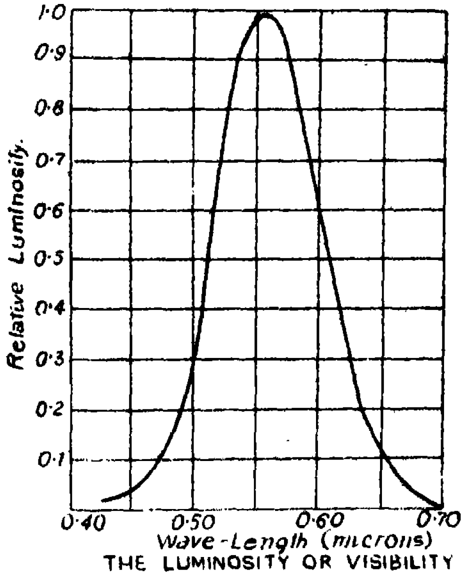
ENERGY-WAVELENGTH CURVES FOR TUNGSTEN FILAMENT.

Fig. II



THE VISIBLE SPECTRUM

Fig. III



THE LUMINOSITY OR VISIBILITY CURVE OF READIANT ENERGY.

Fig. IV

There is yet another type of discharge lamp of high efficiency and low voltage which is gradually getting into prominence for public thoroughfare illumination. Here one finds the joint action of a hot cathode and discharge through mercury or sodium vapour under fairly high pressures. Its efficiency has been near about 40 lumens per watt so that much larger portion of the electrical energy is being utilized in this type of discharge lamps. There is yet another type of illuminating device which has been an indirect outcome of the electrical energy. We know that calcium carbide is an electric furnace product and the generation of acetylene from calcium carbide is too well known. The handy acetylene lamps which can withstand ordinary draughts have found a ready use where temporary illumination of fairly high intensity is in demand.

We do not really realize the amount of light that we actually get during the day-time. At midday in June or July the illumination due to sunlight reaches the tremendous figure of 12,000 ft candles in our tropical clear days. Even in the midst of an industrial city the figure is about 4,000 foot candles under normal conditions. Inside a room in an ordinary bright day at Calcutta not very close to a window in the ground floor the usual figure comes to about 25 foot candles. On any gloomy day the light varies in the different portions of our laboratory, but it has never been found to be below 10 foot candles. This gives an idea of the usual illumination that we enjoy every day.

Now let us consider the type of illumination that we use in our house either for general purposes or for the purposes of reading. In a recent attempt to ascertain this factor it was found that in an average room of 15′×12′ with two lights of 60 watts, the floor illumination never exceeds 2 ft candles. Recently there has been an attempt to determine the actual value of light as required in different public places. Some results are given below.

Factories

On the space :	Recommended illumination, lux, (average) 10 lum. 1 ft candle (approx.)
(a) Roadways, yard thoroughfares.	10-5
(b) Storage spaces, aisles and passages, etc.	30-20
On the work :	
(c) Where discrimination of detail is not essential	50-30
(d) Where slight discrimination of detail is essential	80-50
(e) Where moderate discrimination of detail is essential	120-80
(f) Where close discrimination of detail is essential	180-120
(g) Where discrimination of minute detail is essential	1000-150

Schools

On the space :	
(1) Walk, drives, etc.	10-5
(2) Playgrounds, outdoor, if used at night.	40-20
(3) Playgrounds, outdoor, if used at night for basketball, etc.	120-80
(4) Storage space, passages, not used by pupils.	20-10
(5) Boiler rooms, power plants, and similar auxiliary spaces.	30-20
(6) Stairways, aisles, exits, elevator cars, washrooms, toilets, locker, spaces. dressing rooms.	40-20
(7) Recreation rooms, gymnasia, swimming pools.	120-80
On the work :	
(8) Auditoriums, assembly rooms.	40-20
(9) Auditoriums, assembly rooms etc., if used for class or study purposes.	120-60
(10) Class rooms, study rooms (desk tops).	120-60
(11) Classrooms, study rooms (chairs, black-boards).	120-60
(12) Libraries (reading tables, cat).	120-80
(13) Libraries (bookshelves, vertical plane).	60-40
(14) Laboratories (tables, apparatus).	120-80
(15) Manual training rooms, workshops.	120-80
(16) Drafting rooms, sewing.	150-100

From the figures above mentioned it is evident how low the light values we are at present working with are. There is a common prejudice prevalent in this country that better illumination has led to lowering of eyesight. It may be true that glare of light is not salutary for the eye but when we consider that the eye which is accustomed to work with 20 to 30 ft candles in an ordinary living room in the day-time keeps perfectly well, it is difficult to believe that little illumination during the evening hours can prejudicially affect our eyesight.

Tea in North East India

P. H. Carpenter
Chief Scientific Officer to the Indian Tea Association.

Early History

THE early history of tea is lost in the mythological legends of ancient China but by the fourth century A.D. tea growing in China had developed to the extent of being recognized as of agricultural importance. It was probably about this time that tea drinking was introduced into Japan, but tea culture was not introduced before about the ninth century A.D.

In the sixteenth century A.D. European literature contains a number of references to tea, but it was not until the Dutch brought tea to Holland at the beginning of the 17th century A.D. that tea drinking was introduced into Europe. From then onwards the consumption of tea has gradually increased. It became a fashionable drink in England about 1660 and has continued to gain steadily in popularity. Tea at first was brought from China with perhaps a small quantity from Japan. Only after the monopoly of the China tea trade was lost to the East India Company was serious consideration given to the possibilities of growing tea in India.

In 1823 Major Robert Bruce found indigenous tea growing in the hills in Assam. Eleven years later, in 1834, the Tea Committee reported that the tea shrub is, beyond all doubt, indigenous in Upper Assam. Dr Wallich, a member of the Tea Commission appointed in 1835, logically argued that since the native plants were actually tea there was no need to import the China tea seed. The Commission's first attempt to grow indigenous tea seed on a sand bank of the Brahmaputra resulted in a failure, but another attempt in 1837 to grow indigenous tea at Chubwa 18 miles from Dibrugarh met with greater success.

Early opinions upon the relative values of indigenous and China tea were divided, so that many of the tea gardens of India were planted out with China tea seed. It has taken many years for the indigenous varieties to replace the China type and even today there are still areas of the China type to be found in all the tea districts of North-east India. In Darjeeling there is much of the China varieties still grown.

Botany

The tea plant *Thea Sinensis* L. is a tree or shrub that grows at times to a height of 30 ft. The leaves are alternate and evergreen. The length of the mature leaf varies from 2" up to 12 inches in length. The flower buds originate singly and in clusters from leaf axils. The flowers are white about 1-1½ inches in diameter having 5-7 permanent sepals and 5-7 petals forming one ring. The stamens are numerous. The anthers are two-celled. The ovary is hairy and 3- and 5-celled. The style is glabrous brownish green in colour and about 1¾ inches in diameter. It is usually three-lobed with 3 seeds. The seed is brown in colour, smooth, about ½ inch in diameter, spherical or flattened.

Owing to the lack of sufficient investigation opinions differ about the varietal divisions. Sir George Watt recognized four principal varieties, Cohen Stuart differs in his classification from Sir George Watt but gives a classification into four or more groups.

Cohen Stuart suggests that the original home of the tea plant is probably in the jungles of Southern Yunnan and Upper Indo-China where tea is found in the wild state.

At Tocklai four distinct types of wild tea have been recognized and perhaps a fifth wild type corresponding very closely to the classification of Sir George Watt.

Of the indigenous tea there are two main types commercially recognized—the one has leaves of a light green colour, whereas the other has leaves of a dark green colour. The latter is considered to be the hardier and to suffer less under severe climatic conditions, whereas the light-leafed variety generally is considered to give the better quality. There are a number of different varieties within these two main types so that it is possible to find a dark-leafed variety giving better quality than a light-leafed variety. Owing to the light-leafed generally being less hardy its use has been largely restricted to the Brahmaputra Valley where climatic conditions are less severe than in the Surma Valley and the Dooars, the dark-leafed type being more generally used under the more severe climatic conditions.

Climate

Tea will grow under such different climatic conditions as are to be found in Ranchi with a maximum temperature of 115°F and Darjeeling with an average minimum temperature in January of 35°F. It however flourishes in a tropical or a sub-tropical climate.

The climatic conditions recorded at the tea experimental stations of India, Ceylon, and Java give probably a good general average since all the stations are situated in the tea-growing areas.

Temperature °F.

	Tocklai N. E. India		S. India		St. Coombs Ceylon		Buitenzorg Java.
	Max.	Min.	Max.	Min.	Max.	Min.	
January	70	50	78	59	72	57	75·4
February	73	53	84	59	75	53	75·6
March	79	60	85	63	76	55	76·1
April	83	67	85	66	75	57	77.0
May	86	72	81	66	73	60	77·1
June	89	76	75	65	70	60	77·0
July	90	78	73	64	69	59	77·0
August	89	78	74	64	71	59	77·1
September	88	76	75	64	71	58	77·5
October	85	71	75	65	71	58	77 5
November	78	60	75	63	72	57	76·0
December	72	51	76	60	73	55	75·9

The average monthly rainfall for the same stations is as follows :—

Rainfall in inches.

	Tocklai N. E. India		Nellakota S. India	
	Rainfall	Wet days	Rainfall	Wet days
January	1·0	5·0	0·4	2 5
February	1·4	7 4	0·3	1·0
March	3·0	10·0	0·2	1·5
April	8·3	15·7	3·2	9·2
May	9·0	18·4	11·2	16·7
June	14·4	22·2	11·2	24·3
July	15·1	23·5	18·8	29·0
August	14·3	22·0	18·3	27·0
September	10·8	19·8	15 4	20·3
October	4·6	10·9	10·2	20·8
November	1·0	4·0	2 8	8·5
December	0·4	2·3	1·2	4·0
	84·3	161·2	93·2	165·8

	St. Coombs Ceylon		Buitenzorg Java	
	Rainfall	Wet days	Rainfall	Wet days
January	5·8	14·2	16·9	
February	3·1	9·0	15·4	
March	4·5	14·0	17·3	
April	6·2	13·2	15·6	
May	14·0	21·8	14·0	
June	10·3	26·8	10·5	
July	12·1	25·6	9·7	
August	8·8	26·0	9·6	
September	6·3	19 2	12·7	
October	12·6	26·0	16·7	
November	7·2	19·0	15·9	
December	3·3	14·5	15·6	
	94·2	239·3	169·9	219

Soil

(The tea soils of North-east India are generally alluvial, except those in the Darjeeling district and the teelas of the Surma Valley, which are of sedentary formation. In physical texture the soils vary between wide limits as can be judged by the following typical analyses on all of which soils tea grows well :

	Mal sand. per cent.	Red Bank	Clay Flat	Peat Bheel
Coarse sand —	64	19	0	0
Fine sand —	16	10	17	7
Silt —	4	12	16	7
Fine silt —	7	18	27	26
Clay —	4	33	28	11
Loss on ignition —	4.8	7·8	8·4	33·0
Organic matter (grandeau)	2 4	2 8	3 7	20 4
Nitrogen —	0·12	0·12	0·20	0·57
Total phosphoric acid	0·081	0·150	0·068	0·194
Available " "	0·019	0·014	0·005	0·053
Available potash —	0.009	0·018	0·014	0·036
Available lime —	0·020	0·028	0·083	0 024
Acidity (Hopkin's) —	150	800	1200	2500
Insoluble silicious matter	85	68	75	55

The factors of essential importance are that the soil shall be acid and that the drainage shall be sufficient. If both these conditions are satisfied it would seem that tea generally will grow and produce crop in proportion to the available food supply. Whether different types of soil produce different qualities of tea has not been determined, for there are no reliable data upon this important subject, but the general opinion is that a medium loam soil is likely to give better quality tea than a very sandy soil; but this can be regarded as no more than a general opinion. Soils that are extremely rich in nitrogen such as peat bheels do give a poorer quality tea.

Manuring

The tea soils of North-east India as a whole are poor soils but the few reliable experiments show that the soils are capable of supplying sufficient phosphoric acid and potash to produce a crop of 800-1000 lbs of tea per acre per annum. The supply of available nitrogen is however generally deficient. When a soil is newly opened out of jungle and planted in tea it has a high fertility, which is gradually lost until the soil is capable of producing a crop of only 400 lbs of tea per acre, at which figure the yield can remain more or less constant. Greater crops can be obtained by nitrogenous manuring and the increase of crop above the unmanured level is proportional to the amount of nitrogen supplied in a readily available form.

A soil with a high cropping capacity unmanured will give a smaller response to an application of, say, 40 lbs nitrogen per acre than a soil of lower fertility, as for instance:

Crop Unmanured.	Crop per acre from 40 lbs nitrogen applied annually for 5 years.	Increase in 5th year.
584 lbs per acre	928	344 lbs
822 " "	968	146 lbs

An experiment carried on for a number of years has shown that the supply of nitrogen in organic form has no advantage over nitrogen supplied in an inorganic form, *e. g.*, sulphate of ammonia in producing either greater crop or improved quality. When the quantity of nitrogen applied was increased over 60 lbs of nitrogen per acre a small decrease in quality was noticed.

As a general statement it can be said that tea in North-east India requires to be manured with nitrogen only and that this can be applied in the cheap inorganic form as sulphate of ammonia and with a dose below 80 lbs of nitrogen (400 lbs sulphate of ammonia) per acre per annum loss of quality is not likely to be appreciable.)

Cultivation

Many and varied have been the kinds of cultivation done on tea soils. Most of them have had as one object the stirring and turning over of the soil and as another object the suppression of weed growth. Experiments carried on at Tocklai Experimental Station for a number of years have shewn that for tea the factor that is of major importance is the suppression of weed growth and that soil stirring has had but little effect. (The form of cultivation which will most efficiently and most cheaply suppress weed growth must be regarded as the best cultivation for tea in North-east India.)

(If tea bushes are grown so as to touch each other and so form a heavy-shade canopy over the soil, the growth of weeds is greatly reduced and, indeed, almost suppressed, in which case it would seem from experiments that no cultivation may be needed. This considerably reduces the cost per acre of crop production.

Cultivation on tea gardens is by manual labour, using a hoe (*kodali, mamootie*) about 10 inches deep and about 9 inches in width. Usually the land is deep-hoed to a depth of 8 inches in the cold weather after the tea bushes have been pruned so as to bury the prunings and weeds.

During the growing season the land is light-hoed to a depth of about 3-4 inches so as to bury the weed growth. The number of rounds of light hoeing that may be necessary varies with different circumstances and for young small tea or tea heavily pruned nine rounds may be required, whereas for fully grown tea no cultivation other than one weeding by hand may be necessary.)

Pests

(There are many pests of the tea bush but only a few need to be considered as of major importance. Of these, Red spider (*Tetranychus bioculatus*) and tea mosquito (*Helopeltis thievora*) are the most important. The first can be controlled by cultural and spraying methods, but no real cure has yet been found for *helopeltis*.

The other pests can generally be kept under economic control by spraying and hand collecting, provided such measures are systematically carried out.

Blights

There are a large number of diseases of the tea plant but only a few are of major importance.

Root disease in several forms does considerable damage, usually it is not noticeable until the tea bush is in a moribund condition and nothing can then be done to revive the bush. It has to be dug out and replaced. Systematic attention to the removal of dead and dying bushes can do much to check and control the spread of root diseases.

Stem diseases and particularly those that find entry through an unhealed wound are prevalent and are responsible for the loss of a large number of bushes annually. Pruning and spraying methods have their value for controlling stem diseases but the most important procedure is to avoid unhealed and unprotected wounds.

Leaf diseases are also prevalent, such as Brown blight (*Glomerella cingulata*) which is to be found on all gardens. Black rot (*Corticium invisum*) is responsible for a large loss of crop but does not generally cause the death of bushes.

Another serious leaf disease is Blister blight (*Exobasidium vexans*) which can cause considerable damage but occurs only spasmodically in epidemic form.

Leaf diseases in general can be controlled by spraying with lime-sulphur or Burgundy mixture according to the particular disease present.

Cultural methods are of importance for the control of both leaf and stem diseases.)

Planting

(The choice of the particular jat of tea seed for planting is a matter of considerable importance, since the quality of the tea produced differs with the different jats. It is necessary to consider carefully whether the garden is required to make high-class tea or whether owing to its geographical situation it is preferable for it to produce a large crop of cheap tea. The choice, however, having been made, it is desirable to use only the one type.

Tea seed ripens in North-east India about November. The seed is germinated in wet sand or clean subsoil preferably as soon after it is collected from the tree as possible. So soon as the seeds are cracked they are transferred to the nursery beds which are usually shaded. It is at this time that a first selection can be made, for the seeds that germinate most quickly are those that produce the best plants. The seeds are planted in the nursery at a distance of about 6 inches between seeds. The young plants between the ages of 6 months and 24 months old from seed are lifted from the nursery with a clod of earth so that the roots are not damaged in transplanting to the area where the tea is to be grown.

The spacing between the plants is usually about 4½ feet although this distance may be varied between 4 ft and 5 ft apart. At a distance of 4½ ft apart, if the planting is on the square system, 2,150 plants are required to the acre whereas if planted on the equilateral triangle system 2,480 plants are required to the acre. After planting they are allowed to grow undisturbed until they have developed into strong, healthy plants usually with a single main stem.

Pruning

Single stem plants are regarded as unsuitable for economical working. The young plants are consequently pruned to a height varying between 6″ and 18″ from the ground. After pruning they are allowed to grow until they reach a height of 30″ to 36″ from the ground when they may be plucked. At the next cold weather (12 months) or 24 months after the first pruning the tea is again pruned so as to leave about 2″ of new wood. After that tea is pruned either annually or biennially so as to leave about one inch of new wood. The height of the bush is thus gradually increased until it becomes finally so high as to interfere with the efficiency of the plucking when the bushes are again low pruned to a height varying between 18″ and 24″ from the ground. The particular system of pruning varies in the different districts. In the Brahmaputra Valley pruning is generally done in the cold weather annually whereas in the Surma Valley and the Dooars a very common system is to prune every other cold weather, that is to say, once in 24 months, and in Darjeeling longer intervals are allowed between prunings, the higher the elevation the longer is the interval. In South India, Ceylon, and the Netherland East Indies where owing to climatic conditions the tea continues to grow throughout the 12 months of the year the pruning interval may vary considerably and also there is not the same tendency to have a fixed time for the pruning. Owing to the dry cold weather in North-east India tea ceases to grow sufficiently to make plucking commercially worth while during two to three months, and it is during this period that pruning is done when the bushes are considered to be in a dormant condition. If pruning is done during the growing season in North-east India crop is lost.

Plucking

This is harvesting the crop, for tea is made from the young leaves, the quality of the tea is dependent upon the leaves that are plucked and upon factors that have not been correlated with chemical analysis but the tannin is an important factor, for leaf with a low tannin content gives a poor tea. The distribution of the tannin varies as shown in the following table.

Bud	28%	tannin
1st leaf from the bud	28%	"
2nd leaf from the bud	21%	"
3rd leaf from the bud	18%	"
4th leaf from the bud	14%	"
Stalk between bud and 2nd leaf ..	12%	"
Statk between 2nd and 4th leaves ..	6%	"

The effect of plucking the lower leaves in lowering the percentage of tannin in the bulk of the leaf plucked and thus lowering the quality of the tea made can be readily appreciated when taken into consideration with the ratio by weight the various leaves bear towards the total weight of the shoot plucked, for instance:

	Plucking 2 leaves and a bud	Plucking 3 leaves and a bud
Bud	14%	9%
1st leaf	21%	14%
2nd leaf	38%	25%
3rd leaf	—	28%
Stalk	27%	24%
	100	100

After pruning in the cold weather the bush remains in a dormant condition until the spring growth commences. This is allowed to develop to such a length that when two open leaves and the terminal bud are removed from the shoot there is left about 6 inches of new growth. This measurement is made on the shoot having the highest pruning mark, and the plucking is carried out so as to leave a horizontal surface at this height. The new growth below the plucking mark during the course of the year thickens and matures and is the wood on which the next pruning is made. All shoots that grow so as to give two open leaves and a terminal bud above the plucking mark are removed as crop. There are many variations in the details of plucking methods but they all aim at removing a maximum quantity of the required kind of leaf without damaging the future cropping capacity of the bush. A bush that is very severely plucked is liable to some diseases more than bushes more lightly treated.

The average time taken in North-east India for a leaf to open from a bud is 4 to 5 days. Plucking a bush on the same day of every week thus allows of producing a maximum number of 2 leaves and a terminal bud for plucking. If plucking is delayed for a longer period a third leaf opens which is not required for plucking if high quality tea is to be made, but it is plucked on those gardens that produce lower quality teas.

The tea plant does not continue to grow at a steady rate throughout the year but fluctuates giving five periods of active growth in the year with dormant periods in between flushes. The result of plucking is gradually to mask these well-defined natural periods so that except for the first and second flushes the tendency is to obtain a crop that is not subject to great daily fluctuations. The different flushes, however, have an importance, since they differ in quality of the tea made, the second flush and again the fourth flush giving high quality tea. The fifth flush comes so late in the year in North-east India that the cold dry weather sets in and checks its development.

Manufacture

The tea leaves as they are plucked are collected in baskets in such a manner that the leaf is kept cool. If it becomes hot it looses its green colour, turns red, and is spoilt for making good tea.

The plucked leaf is taken as soon as possible after plucking to the factory where it is spread in the withering house very thinly and evenly at the rate of 1 lb of leaf to one square yard of spreading space on racks or "chungs" that are protected from sun and rain but open to the breeze so that the leaf will slowly loose about 40% of its water content. The soft, flaccid, withered leaf is then rolled so as to twist it on itself and by so doing exerting a strain upon the individual leaf pieces so great as to squeeze out juice which should be retained on the surface of the mass of leaf. The rolling used to be done in India and still is done in China by hand, but commercial gardens in India now use mechanical rolling machines. The effect of rolling is to make the leaf hot and the more severe the rolling action the hotter the leaf becomes so that considerable care has to be exercised to prevent the leaf being overheated. The wet mass of rolled leaf is spread out thinly about 1-2 inches thick in a cool room protected from sunlight, where it is allowed to remain until it has assumed a bright red colour like polished copper. This process is known as fermentation and is for the purpose of giving colour and fullness to the liquor of the finished tea. Tea insufficiently fermented has a light coloured liquor and although astringent yet gives a sense of thinness on the palate.

After fermentation is completed the tea is fired, in large factories, in automatic endless chain-forced air-draught machines. Formerly tea used to be dried by spreading thinly on a wire tray placed over a bright charcoal fire.

Both methods seek to raise the temperature of the tea quickly to a point at which the fermentation processes are stopped, otherwise the tea will loose its astringency and become flat or soft to the palate. The drying is usually conducted at temperature between 180°-200°F and the tea is discharged from the driers at 5% or less moisture content.

Experiments have shown that a loss of quality may take place if the temperature prior to drying rises to 90°F; quality can also be lost if the firing is done at a temperature above 200°F.

Grading

After the firing process is finished the tea is sorted into the grades that are required by the market. This is a purely mechanical process and has to be altered to suit changing market conditions.

If, however, the grading processes are improperly done the value of the tea will be lessened.

The infusion of tea that is made for testing and valuing the tea resembles the infusion that is made for ordinary drinking. It is made by infusing 3 grammes of leaf in 150 c.c. of water for 5 minutes and then pouring the liquor off from the tea.

During the rolling process tea juice is squeezed out of the leaf cells and in the drying process this is dried as a thin layer on the tissue of the leaf. It is this squeezed-out juice that contributes largely to the 5-minute liquor. The thin layer of dried juice on the dry leaf is very brittle and liable to chip off or to be scratched. Any such mechanical damage that removes some of the dried juice causes a loss of tea liquor and a consequent loss in value of the tea. During the grading process the hairs on the undersides of the tea leaves also may become detached. These hairs are responsible for the bits of tea of a golden colour in a mass of tea and are much prized as indicating a good quality tea. The abrading of the hairs means a loss of value to the tea.

After sorting the tea is stored in bins and is usually redried again before packing so as to reduce the moisture percentage to 5%. At higher moisture contents tea loses value. Tea is packed for the market in three-ply wooden boxes lined with lead or aluminium foil and containing approximately 100 lbs of tea.)

Labour

The total number of persons employed in the industry in India in 1934 was returned as 9,05,555 of whom 7,35,170 are employed in North-east India and distributed as follows—

	Persons employed.		
Province.	Permanent estate labour.	Permanent village labour.	Temporary village labour.
Assam	4,79,210	28,023	33,180
Bengal	1,82,968	5,181	6,608

The development of Assam must be attributed very largely to the tea industry directly and to the labour that has been imported by and at the expense of the industry and which after serving on tea gardens has left the estates and opened out land on its own.

Scientific

It is now many years ago since the need for scientific investigation was first recognized as a necessity by the tea industry. In 1893 Dr Lohmann was appointed to investigate tea problems in Java. In 1898 Mr Kelway Bamber commenced work on problems connected with soil and manufacture of tea in Ceylon. In 1899 Dr H. H. Mann was appointed as Scientific Officer to the Indian Tea Association in North-east India, and in 1909 Mr R. D. Anstead was appointed as Scientific Officer to the United Planters' Association of Southern India. In all these countries experimental stations have greatly developed since the initiation of scientific work in tea so that today there are four well-found experimental stations :

In Java	.. the Proefstation voor Thee at Buitenzorg
In Ceylon	.. the Tea Research Institute at St. Coombs
In North-east India	the Tocklai Experimental Station in Assam
In Southern India	the United Planters' Association of Southern India at the Nilgiris.

Statistics

(Owing to the potential tea crop being far in excess of consumption an agreement was entered into between the three largest producing countries to limit exports to give reasonable and steady market. The tea-export-restriction agreement is administered through an International Committee which meets periodically in London. The scheme was put into force in 1933 and has proved highly successful. In addition to the tea exported under the international agreement each country is able to sell an unlimited quantity for consumption within its own frontiers.

In 1935 it was estimated that the tea consumption in India was between 70 to 80 million lbs. The consumption of tea, however, in India is steadily rising.

Under the Indian Tea Cess Act a duty is levied on all exported tea. The amount so collected is made over to a fund which the Government have placed at the disposal of the Indian Tea Cess Committee who allocate funds for propaganda in India and other countries with the object of increasing tea consumption.

In 1934 a total crop of tea was produced in India of 40, 00, 95, 614 lbs distributed throughout the tea-growing districts as indicated in the following table :

Assam	—	—	23,28,35,418	lbs
Bengal	—	—	9,84,01,988	,,
Travancore	—	—	3,11,12,655	,,
Madras	—	—	2,93,42,014	,,
Rest of India	—	—	83,85,539	,,
		Total	40,00,95,614	lbs

This quantity of tea was plucked off 7, 65, 332 acres belonging to 5, 132 plantations.

The average crop per acre varies considerably in the different districts as shown in the accompanying table.

			lbs of tea per acre in 1934.
Lakhimpur (Assam)		—	684
Jalpaiguri (Bengal Duars)		—	597
Cachar (Assam)	—	—	507
Travancore	—	—	446
Nilgiris (Madras)	—	—	379
Darjeeling (Bengal)		—	368
Dehra Dun (United Provinces)		—	335
Mysore	—	—	198

In 1935 there were 625 registered Joint Stock Companies with a paid-up capital equivalent to Rs 49,19,45,000.

The tea industry in the three largest producing countries is highly organized into associations of producers :

In North-east India	(*i*) The Indian Tea Association (*ii*) The Indian Planters' Association
In Southern India —	The United Planters' Association of Southern India
In Netherlands East Indies — Java —	The Algemeen Landbouw Syndicaat
Sumatra —	The Algemeene Vereeniging Rubber-planters ter Oostkust van Sumatra.

These Associations deal with all matters both political and economical that affect the tea industry and the strength and completeness of this organization is demonstrated in the international agreement for restriction of exports and in the international propaganda work that is now in progress. Without such well-organized and representative associations it would have been impossible to bring into being either of the above schemes.

India owes a debt of gratitude to Lord William Bentinck whose perhaps most important act as Governor-General of India was the introduction of tea-growing into India. (This is one of the few cases where a new industry was deliberately introduced and carefully fostered in its early days by the Government of a country. Today tea occupies a high place in importance amongst the exports from India.)

Constitution of the Stars

Sir Arthur S. Eddington

When we turn a telescope on sun, we look at it through its tenuous envelopes—the corona and chromosphere—then down through a few hundred kilometres of its outermost atmosphere, to a level where it becomes too opaque for us to see further. Just as, looking down on the ocean, we can see down a few feet but no further. At the vaguely defined level which is the limit of our vision, the temperature is about 6000°. What lies below that level? What is it like deep down in the interior of the sun—and the other stars? That is what we are going to talk about tonight.

The exploration of the deep interior of the stars began in 1869 with a paper by Homer Lane of Washington, which he entitled, "On the Theoretical Temperature of the Sun, under the Hypothesis of a Gaseous Mass, maintaining its volume by its Internal Heat, and depending on the Laws of Gases as known to Terrestrial Experiment." Evidently he didn't believe in snappy headlines. This paper has been the foundation of developments by Ritter, Emden and others, which are being continued at the present day.

There is a phrase in the title of Lane's paper which I would emphasize; "*Depending on the laws of physics as known to terrestrial experiment.*" That expresses the principle of which I profess myself a devotee. We want to find out how far the phenomena which we observe in the sky agree with, and are a consequence of, the laws that have been assigned to matter as the result of terrestrial experiment. Take ordinary matter—some mixture of the elements that we know—and apply on a large scale the properties of matter and radiation that have been found by experiments on a small scale. Treat it as though you were designing a large dam instead of a large star—with just the same kind of calculations and exercising so far as possible the same kind of foresight. The conditions in the star are very extreme; but the ultimate things to be dealt with—electrons, atomic nuclei, X-rays—are the same in the star as in the laboratory, and we can apply our laboratory knowledge of them. Calculate in this way what will be the properties of the huge mass—what, for example, will be its output of heat and light, what will be its period if it is set pulsating. Calculate "according to the laws of physics as known to terrestrial experiment"; and then turn to the man with the telescope and ask "Is that anything like the stars *you* come across in the sky." It may be that he will point out differences. If the stars have anything new to reveal to us—which the physicist with his limited conditions of experiment has been able to foresee—we shall in this way sort it out from that which is a direct consequence of what we already know or think we know.

Investigations which follow this course of procedure are clearly not speculative. However faulty and uncertain they may be, they keep to the pedestrian path of progress, and eschew flighty conjecture. Parenthetically, may I ask whether it is not possible for critics of theoretical investigations of the stars to find some other term of disapprobation than the term 'speculative'? One prefers to have even one's faults called by the right name. I don't class all speculation as a fault; and it has sometimes happened that important advances have begun in a speculative way. The real harm is when speculative attempts are not sufficiently discriminated from the straight-forward application of existing knowledge; and the converse is no less harmful—when Lane's pattern of investigation, that is to say the results of applying on the stellar scale the laws found in the laboratory, is confused with the frankly speculative theories that have at times been put forward; and—perhaps I may add for the benefit of the mathematicians here—worst of all—when stars constituted of matter obeying the laws of physics, so far as they have been unravelled to-day, are confused with mathematical creations whose only claim on our attention is that they satisfy elegant differential equations.

I will not guarantee that the conclusions that I shall put before you will survive the progress of knowledge in the next fifty years. If by then the stars of gaseous constitution which we accept to-day have given place to liquid stars or solid stars—or, as I once suggested, crystalline stars composed of *gaseous* crystals—well, there have been more surprising changes in science than that. But I believe firmly that the conclusions are such as fit our present scientific knowledge; and that they represent present-day astronomy in step with present-day physics. To use a rather favourite word now-a-days *Unification*—the interest of these investigations is, I think, not so much dependent on the absolute information they yield, as in the unification of physics and astrophysics—enabling us to see one underlying cause or one elementary equation at the root of the most diverse manifestations, tracing its effects in the vacuum tube, in the interior of star, in the diffuse nebulae, and—not least—the system of galaxies which constitutes the cosmos.

I want to leave time to speak of recent problems; so I will run over rather briefly the older part of the subject. Let us suppose that by observation from outside we have ascertained the mass M and the radius R of a star—just those two data. Armed with this information, what can we deduce (by laws of physics) about its interior?

The first difficulty is that although we have ascertained the total mass, we have not found how it is distributed—whether it is fairly uniform throughout the volume of the star or strongly concentrated to the centre. I won't stop to explain how we have got over this difficulty; but it is a side of the problem in which considerable progress has been made in the last year or two. Although we cannot determine the concentration accurately, we can assign limits by purely theoretical deduction. The central density is not less than 5 times the mean density, and not more than 50 times the mean density, so that we know roughly the degree of concentration that we are up against.

Knowing then how the mass is distributed in the structure we can calculate the pressure at any depth. Any civil engineer will tell you that that is possible. So that we know the pressure as well as the density at each point in the interior. Now the density, pressure and temperature are connected by a relation called the *equation of state* of the material; if any two of them are known we can find the third. In this case we know the pressure and density and we can therefore find the temperature—which is, of course, an extremely important thing to find out—in order to realize the sort of conditions we have to deal with. For all the stars except white dwarfs, the equation of state, which connects the temperature with the pressure and density, is the well-known equation of a perfect gas. For the extremely dense matter in white dwarf stars the equation is more complicated; but the theoretical physicist by his terrestrial studies has worked out for us the required equation. (Incidentally he has worked it out wrong—but that is another story and I'll speak about the white dwarfs later. For the present we will keep to the ordinary stars).

The internal temperatures determined in this way are of the order 10 to 20 million degrees Centigrade. Having ascertained this, we begin to realize the state of things that we have to deal with. At this temperature all the atoms will be highly ionized. Light elements such as oxygen will be stripped bare to the nucleus and heavy elements such as iron and lead will retain only a few of the innermost satellite electrons. The rest of the electrons will be free. We have therefore to deal with a population consisting of free electrons, the shattered remnants of atoms, and photons or quanta of radiation. Planck's law determines both the amount and kind of radiation present at a given temperature. At 10-20 million degrees the radiation consists of rather soft X-rays.

Now, we can see more or less what is happening at 10 million degrees in the interior of the sun. Crowded together within a cubic centimetre there are more than a quadrillion atoms about twice as many free electrons and 20,600 trillion X-rays. (British reckoning). The X-rays are travelling with the speed of light, and the electrons at 10,000 miles a second. Most of the atoms are hydrogen atoms or rather, since they have lost their satellite electrons, simply protons travelling at 300 miles a second. Here and there there will be heavier atoms, such as iron, lumbering along at 40 miles a second. I have told you the speeds and the state of congestion of the road; and I will leave you to imagine the collisions. Small wonder if the atoms are found with their garb of electrons badly torn, or even stripped naked.

The stripped atoms are continually capturing free electrons and, so to speak, repairing their dress; but scarcely has the captured electron settled when an X-ray bears down on it and explodes it away. This is not a fanciful picture. These are phenomena which have been found happening in the laboratory when we use X-rays of the same wave-length and electrons of the same speed as in the sun. There is no need to go beyond the limits of terrestrial experiment to discover what is happening to the population, and all the calculations have an experimental basis.

The atoms and electrons are rushing violently hither and thither; but on the whole they do not get any further; gravitation pulls them back and keeps the material of the star in equilibrium. But the X-rays gradually leak outwards. They are subject to gravitation—it is true; but their velocity of 186,000 miles a second is sufficient for escape from any star. It is just the same as in the theory of planetary atmospheres, where gravitation is sufficient to retain the heavier constituents, but the lightest atoms have sufficient velocity to escape. The planet thus loses the lightest gases; and in the same way the star loses, (or, as we say, radiates) photons of radiation. I should explain that, although these photons are X-rays in the interior of the star, they are transformed down to longer wave-length in passing through the last few thousand kilometres of comparatively cool matter; so that it is in the form of light and heat waves that they finally escape.

So you may picture a photon of radiation, barging first one way then another, like a man in a rioting mob—absorbed by an atom and flung out again in a new direction. In this way a photon in the sun will wander aimlessly round in the interior for a million years or more until, just by accident, it finds itself at the exit of the maze—shoots through—and makes a bee-line across space to the Oakridge reflector where Prof. Shapley photographs it.

Having first ascertained the particulars about the population that I have been describing, we can apply the laws (based on laboratory experiment) which determine the amount of obstruction offered by atoms and electrons to the passage of X-rays, and so find how many photons leak out into space per second. We can compare this result with observation—that is to say, we can see whether Professor Shapley catches as many of them with his telescope as (according to our calculation) he ought to catch—in short, whether the star is actually as bright as our calculation makes it.

In the last few years we have found a complication in the calculation which I must now explain. At an earlier stage we had to ask the physicist to supply a formula giving the temperature of a gas when the pressure and density are known. Not unreasonably he will object—"you have not given me enough information. What *is* the gas? Oxygen? iron vapour? mercury vapour? or what? We cannot say. . . ."

But on second thought he withdraws the objection. "Never mind. Ordinarily it would make a big difference, but at the high temperatures we are concerned with it makes practically no difference what element we take. The atoms will be almost completely ionized, that is to say, their satellite electrons will be moving as free particles. We only want to know the average weight per free particle. The number of satellite electrons in an atom is roughly half the atomic weight—so that we shall have roughly 2 units of weight per particle. (For example oxygen). Owing to this remarkable property it has been possible to make considerable progress with the theory of the interior of a star without knowing what chemical elements it is composed of."

Those are the physicist's second thoughts. But on third thought he exclaims—"Bother! There's hydrogen." The rule that there are two units of weight per particle does not work for hydrogen. It has atomic weight 1 and splits up into a proton and electron so that the average weight per particle is ½—instead of 2. That makes a vast difference.

A year or two ago the physicist had some alarming fourth thoughts about neutron; but neutrons are absorbed very easily by atomic nuclei and I think they will have only a transitory existence on the sun, as on the earth, and never form an appreciable part of the population—so we won't worry about fourth thoughts. The crux of the matter is that, for the purposes of these investigations, there are just two kinds of matter, namely *hydrogen* and *not-hydrogen*. Hydrogen gives a much lower temperature than *not-hydrogen*, and therefore lower brightness for a star of the same mass and radius. Our comparison of theory and observation can therefore be used in two ways. We can calculate the brightness of a star, assuming the material to be *not-hydrogen*, compare it with observation, congratulate ourselves on the partial agreement we find, and ponder over the possible sources of the discrepancies which remain—one possible source of discrepancy will be the presence of a significant proportion of hydrogen. The other way is to try various combinations of hydrogen and not-hydrogen until we find the proportion which gives precise agreement of the calculated and observed brightness. That is the method we generally employ now-a-days; the observed brightness of a star tells us what proportion of its mass consists of hydrogen.

Dr. Bengt Strömgren found in this way that the sun, Capella and other typical stars contain 33 per cent of hydrogen. My own calculations agreed precisely. This agreement is rather specially interesting because we adopted different composition for the remaining 66 per cent of the mass. Strömgren used a mixture of rather light elements, familiarly known as "Russell's Mixtrue," believed to agree with the composition of the outer layers determined with the spectroscope; I used a mixture about three times heavier. Our precise agreement confirms what I have already said—that it makes no difference what kind of stellar material you assume—so long as it is *not-hydrogen*. It is still doubtful to what extent the proportion of hydrogen varies in different stars; there is some evidence that it is greater in the most massive stars, but the evidence is not very good. An important paper presented by Prof. H. N. Russell to the Tercentenary Conference was partly devoted to this question.

I must say a word about the agreement of theory and observation. Since we determine the proportion of hydrogen so as to make the observed and calculated brightness agree, we obviously cannot claim that the agreement is a confirmation of the theory. Nevertheless it does furnish a fairly efficient check. Unless the theory were pretty near the truth we should find that for some of the stars which we try, it would be impossible to find any proportion of hydrogen that would bring about agreement. It is satisfactory therefore that all the stars give a reasonable proportion. If Strömgren had found, instead of 33 per cent., an answer which involved the square root of -1 as might easily have happened, we should have concluded that there was something fishy about the theory.

The recognition of white dwarf stars with density far transcending that of any terrestrial matter is one of the more spectacular developments of the study of stellar constitution. A cubic inch of the matter of the Companion of Sirius weighs about a ton; and some of the more recently discovered white dwarfs appear to have higher densities even than that. In order to explain a new point which has arisen in connection with the theory of these stars, I must go back to past history. In 1924 the mass-luminosity relation—that is the formula expressing the result of the calculation I have been describing—was worked out; and, on comparing with observation, it turned out that it was obeyed not only by the diffuse giant stars for which it was intended but also by the dwarf stars with densities greater than water for which it was *not* intended. This was a complete surprise. But the explanation was not difficult to find. We had been taking it for granted that stellar matter would cease to behave as a perfect gas when the density approached that of ordinary liquids or solids. Ordinary terrestrial atoms then begin to jam together and the material becomes almost incompressible. But in the stars the temperature of 10 million degrees causes most of the satellite electrons to be stuffed away from the atom and what is left of the atom is a tiny structure. The atoms or ions are so reduced in size that they will not jam until densities 100,000 times greater are reached. For this reason, the perfect gas state continues up to much higher densities in the stars. The sun and other dense stars insisted on obeying the theory worked out for a perfect gas, as they had every right to do since their material was perfect gas.

There was therefore nothing to prevent stellar matter from becoming compressed to exceedingly high density; and it suggested itself that the densities which had been calculated from observation for certain stars called white dwarfs, which had seemed impossibly high, might be genuine after all.

In reaching this conclusion I was not without a certain misgiving. I was uneasy as to what would ultimately happen to these super-dense stars. The star seemed to have got itself into an awkward fix. Ultimately its store of subatomic energy would give out and the star would then want to cool down. But could it? The enormous density was made possible by the high temperature which shattered the atoms. If it cooled it would presumably revert to terrestrial density. But that meant that the star must expand to, say, 5,000 times its present bulk. But the expansion requires energy—doing work against gravity; and the star appeared to have no store of energy available. What on earth was the star to do if it was continually losing heat, but had not enough energy to get cold!

The high density of the Companion of Sirius was duly confirmed by Doctor Adams—but this puzzzle remained. Shortly afterwards Professor R. H. Fowler came to the rescue in a famous paper, in which he applied a new result in wave-mechanics which had just been discovered. It is a remarkable coincidence that just at the time when matter of transcendently great density was discovered in astronomy, the mathematical physicists were quite independently turning attention to the same subject. I suppose that up to 1924 no one had given a serious thought to abnormally dense matter; but just when it cropped up in astronomy it cropped up in physics as well. Fowler showed that the newly discovered Fermi-Dirac statistics saved the star from the unfortunate fate which I had feared.

I will say a word or two about Professor Fowler's explanation. My colleague Fowler was in his youth a pure mathematician, and I am afraid he has never really recovered from this up-bringing. Consequently, although his paper contained reassuring equations, it did not clearly reveal the simple physical modification of ideas, which wave-mechanics brought about. He proved that the star would manage all right. But, as you may have inferred from Professor Hardy's revelations the other night, I am not an extreme worshipper of proof. I want to know *Why?* ; a proof does not always tell you that. As Clerk Maxwell used to ask "What's the go of it." Well, in this case the go of it was that whereas the older theory said that atoms could only be ionized by high temperature the new wave-mechanics said that high temperature was not essential because they could also be ionized by crushing them under high pressure. Several writers tumbled to it, before I did, that that was what Fowler's rather mysterious result really meant; but I think that it is still not at all generally known. You see this allows the star to cool down and still retain its enormous density—which the older classical physics did not.

Not content with letting well alone, physicists began to improve on Fowler's formula. They pointed out that in white dwarf conditions the electrons would have speeds approaching the velocity of light, and there would be certain relativity effects which Fowler had neglected. Consequently Fowler's formula, called the *ordinary* degeneracy formula, came to be superseded by a newer formula, called the *relativistic* degeneracy formula. All seemed well until certain researches by Chandrasekhar brought out the fact that the relativistic formula put the stars back in precisely the same difficulty from which Fowler had rescued them. The small stars could cool down all right, and end their days as dark stars in a reasonable way. But above a certain critical mass (2 or 3 times that of the sun) the star could never cool down, but must go on radiating and contracting until heaven knows what becomes of it. That did not worry Chandrasekhar; he seems to like the stars to behave that way, and believes that that is what really happens. But I felt the same objections twelve years earlier to this stellar buffoonery; at least it was sufficiently strange to rouse my suspicion that there must be something wrong with the physical formula used.

I examined the formula—the so-called relativistic degeneracy formla—the conclusion I came to was that it was the result of a combination of relativity theory with non-relativistic quantum theory. I do not regard the offspring of such a union as born in lawful wedlock. The relativistic degeneracy formula—the formula currently used—is in fact baseless; and, perhaps rather surprisingly, the formula derived by a correct application of relativity theory is the ordinary formula—Fowler's original formula which everyone had abandoned. I was not surprised to find that in announcing these conclusions I had put my foot in a hornet's nest; and I have had the physicists buzzing about my ears—but I don't think that I have been stung yet. Anyhow, for the purposes of this lecture, I will assume that I haven't dropped a brick.

I venture to refer to a personal aspect of this investigation since it shows how closely different branches of science are interlocked. At the time when my suspicion of the relativistic degeneracy formula was roused by Chandrasekhar's results, it was very inconvenient to me to spare time to follow it up, because I was immersed in a long investigation in a different field of thought. This work which had occupied me for six years was nearing completion and there remained only one problem, namely the accurate theoretical calculation of the cosmical constant, needed to round it off. But there I had completely stuck. I had, however, secured a period of four months free from distractions which I intended to devote to it—to make a supreme effort, so to speak. But having incautiously begun to think about the degeneracy formula I could not get away from it. It took up my time. The months slipped away, and I had done nothing with the problem of the cosmical constant. Then one day in trying to test my degeneracy results from all points of view, I found that in one limiting case it merged into a cosmical problem. It gave a new approach to the very problem which I had had to put aside—and from this new approach the problem was soluble without much difficulty. I can see now that it would have been very difficult to get at it in any other way; and it is most unlikely that I should have made any progress if I had spent the four months on the direct line of attack which I had planned.

The paper which I read earlier in this Conference giving a calculation of the speed of recession of the spiral nebulae and the number of particles in the universe had an astronomical origin. It was not, however, suggested by consideration of the spiral nebulae. It arose out of the study of the Companion of Sirius and other white dwarf stars.

I mentioned that we only gradually came to realize that ionization could be produced by high pressure as well as by high temperature. I think the first man to state this explicitly was D. S. Kothari. Stimulated by some work of H. N. Russell, Kothari has made what I think is an extremely interesting application. The relation of ionization to pressure is a curious one; for at low pressures we decrease the ionization by increasing the pressure; but the ionization must have a minimum, for at high pressures the Fermi-Dirac complication steps in and the ionization ultimately increases with pressure. No one seems to have bothered much about this revised ionization law; they have been content to recognize or I think rather to guess that in white dwarfs the ionization would be pretty high. Kothari, however, has treated it seriously and worked out the degree of ionization in various conditions, including comparatively small masses in which the pressure is relatively low and the ionization is not very high.

I turn now to the subject of sub-atomic energy which we believe to be the source which maintains a star's heat. This is a matter on which, until about three years ago, terrestrial experiment gave us no help at all. Conditions have now changed, and physical laboratories throughout the world have given themselves up to an *orgy of atom-splitting.* It is of immense importance for the future of astronomy that a new laboratory technique enables us to experiment directly on the processes of liberation of energy by transmutation of atomic nuclei; since these are almost certainly the processes which keep the stars alight. But at present it is too early to expect results this way. The theory of stellar constitution, which I have been describing, was built up without any laboratory knowledge of a sub-atomic energy. This was possible because the problem of the source of maintenance of a star's heat could be segregated almost completely from the rest of the problem. By Lane's method we could determine the temperature—how much heat there was in the star—without speculating as to how it came to be there; and we could show that a star so endowed must radiate at the moment a calculable amount of light and heat—without inquiring how it managed to go on radiating it for thousands of millions of years. In short the structural problem could be segregated from the evolutionary problem.

The only point at which the segregation is not complete is this:—The concentration of density towards the centre of a star depends to some extent on how the source maintaining the heat is distributed. It seems clear from present-day experiment as well as from astronomical evidence that the liberation of sub-atomic energy increases rapidly with temperature; so that we may expect it to occur mainly in the hottest central part of the star. This has the effect of diminishing the concentration of density to the centre—making it less than in the standard model which has generally been employed. This effect is, however, limited; because if the star overdoes it convection currents are set up, which bring about compensation. To describe our present conclusion I must use technical terms:—The density distribution near the outside has a polytropic index 3 which gradually diminishes to 1.5 at the centre where there is a convective core. I am speaking of ordinary stars such as the sun; but curiously enough this specification of the density distribution applies also to white dwarfs—for which it has long been the recognized model—though in the white dwarfs it comes about in quite a different way.

Apart from this refinement, the researches which I have hitherto described, are not affected by theories of sub-atomic energy. But they put us in a favourable position to learn something about the laws of sub-atomic energy. Many well-known lines of argument have convinced us that the sun and stars have a life-time to be reckoned in thousands of millions of years—which means that evolutionary changes are extremely slow and that the heat radiated by a star into space is almost exactly balanced by the heat liberated from sub-atomic sources in the interior. So when we measure the radiation of a star, we measure the generation of sub-atomic energy. You see then that the measurement of sub-atomic energy is just a common everyday astronomical measurement.

To the engineer the release of sub-atomic energy on a practical scale is, and seems likely to remain, a Utopian dream. To the physicist it was, until three years ago, a field of uncontrolled theoretical speculation. To the astronomer it has long been an everyday phenomenon which it would be absurd to close his eyes to.

Having then measured the rate of release of sub-atomic energy in all types of stars, we can correlate it to the temperatures and densities which we have found in the interior. This more or less direct investigation of the conditions of release can be supplemented by a theoretical examination of the conditions of stability of stars containing such a source—a line of attack initiated by Prof. H. N. Russell.

If the star contracts, the liberation of sub-atomic energy must be stimulated; otherwise the star is unstable. We cannot deduce astronomically whether the stimulus comes from the increased temperature or the increased density; but for simplicity we shall suppose it to be mainly the temperature. Then each star contracts until its internal temperature reaches the value at which the liberation of sub-atomic energy the heat radiated and there it sticks—not quite indefinitely but for a very long period until the sources of sub-atomic energy show signs of exhaustion. The stars on the Main Series appear to be those which have reached this balance and stuck. Now it is one of the results of our previous investigations that the stars of the Main Series from the most massive to the lightest have practically the same internal temperature. We used to give the central temperature as 40,000,000°, but the figure has come down—partly by the recognition of the abundance of hydrogen and partly by the substitution of a less condensed model and the present estimate is about 15 million degrees. But whatever it is, it is nearly the same for all. It appears therefore that on the Main Series a small star which requires a small amount of energy per gram to maintain its radiation and a massive star requiring 1000 times as much energy per gram both have to rise to 15 million degrees to liberate. Or to put it another way the liberation must increase 1000 fold in a rise of temperature scarcely large enough for us to notice in our rather rough calculations.

Another result of the examination of the stability of a star is important. The rate of liberation of sub-atomic energy must increase with temperature but not too fast; if it increases more steeply than a certain limit the star will be thrown into pulsation. Some stars do pulsate, namely the Cepheid variables but the majority do not. Perhaps we may infer that the actual law of increase is pretty near the limit, so that the conditions of most of the stars are on the one side and those of the Cepheids just beyond it. But there is a way by which the star can escape this pulsatory instability. We have been supposing that the response of the sub-atomic energy to the stimulus of temperature is immediate; if there is a lag—if the rising temperature stimulates the formation of active material which emits the energy later on in its own good time, or if it starts a chain of processes of which the actual energy liberation is the last then there will be no pulsation. A lag of some days at least is required. Provided there is this lag, the stars will be stable, even though the energy liberation increases very rapidly with the temperature—as our observational results for the Main Series stars indicate and as is also indicated by the recent laboratory experiments.

This is the main information about sub-atomic energy that we have learned from astronomy. I suppose that, taken altogether, it seems a meagre amount. But its importance is considerably enhanced, when we recall that on almost every point it was completely at variance with the views then held by physicists. The only form of liberation of sub-atomic energy with which the physicist was then acquainted was that of the radio-active elements—a process independent of density and unaffected by temperature unless the temperature was far higher than 15 million degrees; and he was inclined to be intolerantly disposed towards considering any other process, no matter how strong the astronomical evidence might be. I cannot but think that this is an instance of the harm done by the writers who give the impression that stellar investigation is a field of loose speculation. Physics and astrophysics are one subject, following the same rules of progress, recognizing the same standards of rigorous deduction, and utilizing the same corpus of accepted knowledge; and liable to the same failures through our human limitations.

Various attempts were made to find a loophole for admitting much higher temperatures in the stars so as to satisfy the physicist's objection to admitting energy liberation controlled by low temperatures; for example, Jeans' theory of elements of very high atomic weight, and Milne's theory of the existence of a core of white dwarf density in ordinary stars like the sun. We can scarcely say that such suggestions are impossible without attributing to our existing knowledge of the laws of physics greater completeness than we care to claim. But I think it can be said firstly that these theories were found on examination not to fulfil what was initially claimed for them—on the strength of which they were recommended. And secondly it is not unfair to describe them as agreeing with the physicist on a matter as to which he knew nothing at the expense of disagreeing with him on matters as to which he claimed to know a great deal.

All that has changed now that these sub-atomic processes have been studied in the laboratory. They are found to require comparatively low speeds of the particles, corrseponding to comparatively low temperatures such as the stellar investigations had indicated. The first criticism I heard, after the experiments on disintegration of elements by protons had begun, was that 40 million degrees was too high a temperature for the sun; and it could not be much over 15 million degrees without blowing up. Happily we had been beforehand; and the revised astronomical calculations already lowered the temperature to a point which makes the sun safe for posterity.

New experimental discoveries have helped us to come to an important decision as to the nature of the sub-atomic energy released in the stars. For fifteen years we have been hesitating between two alternative suggestions. The energy might be provided by electrons and protons annihilating one another, thus setting free the whole energy of their constitution in the form of radiation. Or it might be provided by transmutation of the elements. Even in this application it remains true that we need distinguish only two kinds of stellar matter, namely hydrogen and not-hydrogen; so the transmutation can be more precisely defined as the transmutation of hydrogen into not-hydrogen. The annihilation of a proton by an electron corresponds to the complete disappearance of a hydrogen atom. The energy released by the transmutation of a hydrogen atom into other elements is only about 1/120 of the energy which would be released by its complete disappearance. Thus the annihilation hypothesis provides more than 100 times as much energy as the transmutation hypothesis and the possible life-time of a star is correspondingly increased.

Attempts to decide between the two alternatives by astronomical evidence were inconclusive. But recent progress in physics seems to point decidedly to the transmutation hypothesis; and the annihilation hypothesis seems to have been generally abandoned. Perhaps the most serious blow to it was the discovery of the positron by Anderson at Pasadena. The positron, not the proton, is the true opposite of an electron; and positrons and electrons *do* annihilate one another. Our lust for slaughter being thus satisfied, it would be incongruous to bring in the proton as an alternative agent; and we look on the supposed annihilation of electrons by protons as a rather misdirected anticipation of the real cancelling.

Simultaneously, the very long time-scale which corresponds to the annihilation hypothesis had lost its attractiveness. The phenomenon of the expansion of the system of the galaxies which constitutes our universe, as well as studies of the stability of individual galaxies make it difficult to asign an age to the stars greater than 5,000 million years. The radiation required for this period is amply provided for by the transmutation hypothesis and the hundredfold greater energy provided by the annihilation hypothesis would only be an embarrassment.

Both hypotheses were originally theoretical suggestions; but the transmutation hypothesis can now claim a definite observational basis. Take the sun which we have found to be 1/3 hydrogen and 2/3 not-hydrogen. At 15 million degrees the hydrogen is ionized and its nuclei—i.e. the protons—are travelling at average speeds of 500 miles a second. We know that in the laboratory protons of this speed attack and enter the nuclei of other elements—the not-hydrogen—and bring about transmutations in them. We may hope in due time the physicists will be able to trace for us the whole sequence of changes direct and indirect which result, so that we shall be able to find quantitatively the rate of disappearance of free hydrogen under these conditions, and so find the amount of sub-atomic energy of this kind liberated in the sun. If it is found to agree with the sun's rate of radiation, we shall then have definite proof that no other source—such as annihilation—is operative. We are, of course, far from having the necessary knowledge at present. It is complicated by the fact that although the protons enter atomic nuclei and change the nuclei into new elements, in many cases the new nucleus breaks down, after a short time a proton is shot out and no permanent transmutation results. Such permanent transmutation as is observed comes at the end of a chain of processes of which the attack of the proton on the nucleus was the first. It is interesting to notice that this was already foretold by the astronomical investigations which, as I have said, demand a time-lag between a stimulation of the activity of the protons by rise of temperature and the corresponding increase of output of sub-atomic energy.

I have given you my impression of the way in which this new knowledge works in with, and so far as we can see, agrees with the existing theory of stellar constitution; not because I lay stress on the rough conclusions that can be drawn in the turmoil of new discovery. The data available at present are far too scrappy. But because I want to show how intensely important the work on atom-splitting now in progress is for astronomical developments—so that we may look forward to great developments in the future.*

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Birds of Darjeeling

Satya Churn Law

THE avifauna of *Darjeeling—a fascinating* study no doubt—obviously conjures up a vision of so many gay birds quite dissimilar to what we see in the plains, of gorgeous colour and sweet notes, so that we feel interested and inquisitive not only to know about their habits and life-history, their curious displays, their haunts and habitats, and many other problems of biology connected with their distribution, which necessarily involve discursion into the fields of geology, botany, and zoo-geography; take, for instance, the case of remarkable affinity and parallel distribution noticeable in forms in such widely separated areas as the Himalaya, the hills of Ceylon and Malabar; and again the question of colonization of the afforested area of the Himalaya from below Kashmir to Bhutan which Col. Meinertzhagen's researches bring to the fore. The subject raises so many issues which will hardly admit of a fuller treatment within the space at my disposal, and regard being had to the limitations inherent in a short article like the present one, I would only propose to touch on some broad and general aspects of the altitudinal distribution of the birds of Darjeeling within the confines of the district.

The nature and character of a country, the extent of diversity in its physical features and its climatic conditions generally determine its characteristic flora and fauna, and this consideration leads us at the very outset to an examination of the physical peculiarities of Darjeeling. The latter, as we know, comprises a mass of mountains leading like a stupendous stairway from the *tarai,* geographically a part of the Bengal plains, which skirts its base, to the Himalaya, being linked up beyond its political boundary with the great range of snowy peaks. It is thus naturally cut up into two well-defined sections, the hills and the plains, and barring its plains tract Darjeeling may be viewed as resting within the confines of what is known as Sikkim-Himalaya. One may, therefore, realize that the dissimilarities that are noticeable in the physical features of the entire area are what are inherent in an extensive complex system of mountains and valleys with an irregular belt of the low-lying plains immediately surrounding the foot of the hills. And if one takes note of the striking difference in altitude of from 300 ft (plains level) to 11,923 ft (at Sandakphu) the disparity and gradations in climatic conditions become obvious. Such disparity is all the more in the interior of the district where the innumerable spurs and ridges that run down from the main ranges on their either flank form a network of valleys and gorges, very often low, deep, and tortuous, down which dash the streams and torrents of water precipitated by the heaviest rainfall in the wake of the S. W. monsoon. Local rain is also much in evidence before the advent of this monsoon, and while the impact of the rainfall is met by the opposing face of the outlying spurs much of the water is carried down with the consequent result that the wettest tract is at the base of he hills. High humidity follows as a matter of course, and dampness and steamy heat characterize the climate of the foot-hills and adjoining plains, the valleys and riverbeds. Immense variations, however, in rainfall, temperature, and humidity are inevitable in the peculiar circumstances of the divergent physical features of Darjeeling relative to accidents of protection, exposure, and slope of the ridges, thus conducing not a little to the emergence of such diverse climatic conditions. The latter react on vegetation, giving rise in suitable environments to distinctive zones or plant-associations which harbour certain types of birds. Such zones are classified as follows:—

I.	Tropical	Submontane or *tarai* Hilly	300-2000′
II.	Sub-tropical	— —	2000-5000′
III.	Temperate	— —	5000-9000′
IV.	Sub-alpine	— —	9000-13600′

In the *tarai* vegetation ranges from giant grass and matted cane-brakes to *sal (Sharea robusta)* forest of the higher land alternating with tangled jungle—much of it now cleared for cultivation. Amidst semitropical vegetation at about 4,500 ft appear the oaks which gradually becoming more numerous at 5,000 ft give rise to what is known as the oak forest region, really a sub-temperate zone where the under-growth is perceptibly less rank and bamboos, palms, plantains, the screw pines and tree ferns are seen. Above 5000 ft is the temperate zone in which maples, oaks, chestnuts, and magnolias abound. The trees are mantled with ferns, mosses, and epiphytic orchids. The sub-alpine zone is practically the region of the rhododendron and pine forests. *Abies Webbiana,* commonly known as silver fir, appears above Tanglu, forming in some places open forests and usually putting on a blasted appearance evidently as the effect of lighting and violent storms to which they are exposed. The alpine zone lies beyond the sphere of Darjeeling where the limit of trees is reached and the line of perpetual snow appears.

Such is only a rough idea of the diversified features of the place admitting of some broad divisions into zones due to altitude, climate, and other factors which we owe to Hooker and others for pointing out. It is difficult, however, to lay too much stress on the definition of the zones in pointed reference to the specific vegetation mentioned by Hooker. For not only are there constant changes going on for human requirements which alter much of the character of the virgin soil and primitive forest, some irregularity naturally arises due to exigencies of the physical peculiarities of the country, and nowhere is this more in evidence than in the deep, narrow valleys and riverbeds where tropical vegetation meets the lowest belt of the temperate flora reacting in some degree in a similar way on the conditions of birdlife.

The several zones with their special ecological characters harbour a varied avifauna ranging from the forms peculiar to the plains to those specially adapted to high elevation. While the plains species usually have their habitat in the low-lying belt surrounding the foot of the hills, and the diverse mountain forms are normally distributed in their range within the respective zones, constancy of distribution within the limits of such zones cannot always be looked for, for very few birds are strictly resident, the majority being given to considerable movements, not only seasonal as well as migratory, but also under stress of weather and other circumstances (*e.g.*, denudation of forest, etc.). It is at the period of nesting when the conditions of birdlife in the district are practically stable with very little sign of such movements that one can form an idea of the distribution of the species in relation to the zones to which they are attached.

Take the case of some common birds. We are more or less familiar with the Shama *(Kittacincla malabarica indica* S. Baker), the Bhimraj or the Racket-tailed Drongo *(Dissemurus paradiseus grandis* (Gould), Harewa or the Gold-fronted Chloropsis (*Chloropsis a. aurifrons* Temm. & Laug.), the Hill Mynah or Grackle (*Gracula religiosa intermedia* Hay) and the Bengal Bulbul *(Molpastes cafer bengalensis* Blyth) which are noted as cage-birds. All of them are found in the plains tracts of the district, and although they move about a good deal, such movements are fairly confined to their tropical range seldom exceeding a few hundred feet beyond it which may very well come under the semitropical zone. A striking variation, however, is noticeable in the movement of the Common Bengal Bulbul which approaches an elevation well-nigh in the lowest belt of the temperate zone. I have found the bird in the environs of the station of Darjeeling below Lebong. This phenomenon is only explainable by the fact that the deep, narrow valleys, where almost tropical or semitropical conditions prevail, provide a channel for its ascension or decent to such extremes. And it should be noted that even at the extreme limit of its ascent the bird frequents the surroundings of the valleys. It is sometimes difficult to follow the movements of some birds like the Long-tailed Broadbill *(Psarisomus dalhousiae* Jameson), the Orange-bellied Chloropsis (*Chloropsis h. hardwickii* Jerd. & Selby), the Northern White-Eye (*Zosterops palpebrosa elwesi* S. Baker), which are sometimes met with in the immediate vicinity of the town of Darjeeling. A careful observation reveals, however, that their distribution has always a reference to valleys and gorges through which they move up or down, as occasion arises, to find their congenial haunts. Three species of Hornbills, which are known to us as *Dhanesh* occur in Darjeeling, and of these

Dichoceros b. bicornis Linn. or the Great Hornbill is found generally from the base of the hill to a limit which comes practically well over the semi-tropical zone, wherever there is heavy forest. Cultivation and clearance of jungles have brought rapid changes in its normal habitat. Hence arises the necessity for its search for other suitable haunts and consequential variation in its range of distribution. The Rufous-necked Hornbill (*Aceros nipalensis* Hodgs.), though it is partial to low valleys, has been found to invade the fringe of the temperate zone.

Coming to the birds of the temperate zone we are confronted with the species populating roughly an area from about the height of Kurseong to an elevation of a little over 1000 ft above the town of Darjeeling. I have referred to the characteristic vegetation of this zone and need only draw the reader's attention to one striking feature, *viz.*, the mantle of mosses and fern-like growth covering the shrubs and trees. These mosses, etc., harbour plenty of insect-food for the birds and also provide nesting material and even nesting site for them. Some resident birds of this zone are the Sikkim Red-headed Laughing-Thrush (*Trochalopteron erythrocephalum nigrimentum* Oates), the Red-headed Tit (*Ægithaliscus concinnus concinnus iredalei* S. Baker), the Red-tailed Minla (*Minla ignotincta* Hodgs.), the Yellow-naped Ixulus (*Ixulus f. flavicollis* Hodgs.), the Striated Green Bulbul (*Alcurus striatus* Blyth), the Large Niltava (*Niltava g. grandis* Blyth), the Rufous-bellied Niltava (*Niltava s. sundara* Hodgs.), the Chestnut-bellied Rock-Thrush (*Monticola rufiventris* Jerd. & Selby), the Chestnut-headed Babbler (*Pseundominla c. castaneiceps* Hodgs.), the Chestnut-headed Wren (*Tesia c. castaneocoronata* Burton), the White-browed Shortwing (*Heteroxenicus cruralis* Blyth), the Dark-grey Bush-Chat (*Rhodophila f. ferrea* Gray). All of them are fairly constant to their zone in the breeding period, but in winter some descend down to the *tarai.*

The Himalayan range is a great centre of distribution of many Pheasants, of which the Kalij (*Gennaeus leucomelanos melanotus* Hutton) generally keeps to the temperate zone, while the Tragopan or the Crimson Horned Pheasant (*Tragopan satyra* Linn.) has a wider range, specially in summer when they invade the sub-alpine zone. Winter conditions, however, are responsible for much of the variation in their movements when the zones cannot be clearly defined. The Monal (*Lophophorus impejanus* Lath.) and the Blood Pheasant (*Ithagenes c. cruentus* Hardw.) are found no doubt in the sub-alpine zone of the district, but they ascend still higher altitudes, being clearly palaearctic species as distinguished from purely Indian forms, known as oriental, which hardly cross their zoo-geographical boundary in the Himalayas. This boundary line is no doubt arbitrary and has been regarded as following a course at a fixed altitude in the Himalayas. It is stated to occur at more or less indefinite limits from 8,000 ft upwards, yet is relative to the vegetation, bearing a close connection with the lowest limits of the coniferour forests, and is thus in reality a belt below the pines. It will be seen, therefore, that so far as the district of Darjeeling is concerned, somewhere in its temperate zone falls the border-land between the palaearctic and oriental regions, where an admixture of types of avifauna of the two regions is noticeable. The pines and rhododendron jungles, as we may see in our ascent to Sandakphu, are typical haunts of many palaearctic birds, *e.g.*, Nutcracker (*Nucifraga caryocatactes hemispila* Vig.), the Himalayan Cole-Tit (*Lophophanes ater aemodius* Blyth), etc., as much as of diverse oriental forms, *e.g.* Yuhina, both Stripe-throated and Slaty-headed (*Yuhina g. gularis* Hodgs. and *Y. o. occipitalis* Hodgs.), Hodgson's Fulvetta (*Fulvetta v. venipectus* Hodgs.), the Black-faced Laughing-Thrush (*Trochalopteron a. affine* Hodgs.) and some gorgeous Sunbirds like *Æthopyga i. ignicauda* Hodgs., *Æthopyga n. nipalensis* Hodgs. which in summer hover around the rhododendron flowers.

I have attempted to give here only a hurried outline of some broad aspects of the distribution of the birds of the district, and this, I hope, will give some idea of the number and variety of its avifauna. Falling as it does within the confines of the Sikkim-Himalaya Darjeeling, as we have seen, cannot divest itself of its composite geographical character, and in proportion as it preserves this character undespoiled the variety and wealth of its avifauna are discernible to a greater or lesser degree. Space will not permit my discoursing on any other aspect of birdlife, and I would only conclude by enumerating some characteristic birds which inhabit this interesting zoological country.

The Lammergeyer or the Bearded Vulture (*Gypaetus barbatus hemachalanus* Hutton) notorious for being found at an elevation of 24,000 ft during Everest Expedition is seen at Phalut and Sandakphu and is sometimes observed to descend to the elevation of Kurseong. The Himalayan Red-legged Falconet (*Microhierax c. coerulescens* Linn.) revels in the warm environment of the valleys and so does the Frog-mouth (*Batrachostomus javensis hodgsoni* Gray). The latter as much as the Broadbill (the long-tailed species, *Psarisomus dalhousiae* Jameson commonly seen in the Tista Valley), an aberrant which is found nowhere else and also the Red-headed Trogon (*Harpactes e. erythrocephalus* Gould), the Large Green-billed Malkoha (*Rhopodytis t. tristis* Less.), the Indian Drongo-Cuckoo (*Surniculus lugubris dicruroides* Hodgs.), the Broad-billed Roller (*Eurystomus o. orientalis* Linn.), the Streaked Spiderhunter (*Arachnothera m. magna* Hodgs.), the Fairy Blue Bird (*Irena p. puella* Lath.) are noteworthy species which have their congenial habitat in different elevations of the Tista Valley. Some remarkable high elevation birds that are even found in winter between Sandakphu and Phalut are the Snow Partridge (*Lerwa lerwa* Hodgs.) and Hodgson's Grandala (*Grandala c. coelicolor* Hodgs.). Lastly, the birds which are attached to *jhara* environment, dwelling near cascades or torrents, deserve mention,—the Himalayan Whistling-Thrush (*Myiophonus coeruleus temminckii* Vig.), the White-capped Redstart (*Chaimarrornis leucocephalus* Vig.), the Spotted Forktail (*Enicurus maculatus guttatus* Gould), and Plumbeous Redstart (*Rhycornis fuliginosus* Vig.).

There must have been many obvious omissions in this list, and without attempting to go into further details I need in concluding simply stress the fact of the amazing wealth of the bird fauna of Darjeeling by pointing out that of the 549 species and subspecies (excluding the innumerable waders and ducks migrating over the country) recorded for the Sikkim-Himalaya 90% are found within the limits of the district.*

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* Based on a discourse at the Rotary Club, Calcutta, on Oct. 6, 1936.

Notes and News

All-India Education Conference

This year the All-India Educational Conference will meet at Gwalior. A conference working committee is actively working for the last few months under Mr. V. G. Dani, deputy inspector-general of secondary education, to make the Conference a success. Rao Bahadur Hulye, the Education Member, is the chairman of the reception committee. The following list of sections into which the conference divides up its work will give some idea of its scope.

(1) Childhood and Home education;
(2) Primary and rural education;
(3) Secondary education;
(4) University education;
(5) Adult education;
(6) Vocational Training;
(7) Examinations;
(8) Health and physical education;
(9) Training and Educational Research;
(10) Moral and Religious education;
(11) Internationalism and Peace.

Each section will have a full programme of lectures, discussions, and demonstrations.

Psychoanalytic Treatment

Though psychoanalysis to-day is one of the most important schools of psychology, it started as a branch of medicine, and is still claimed by its adherents to be highly efficient in treating mental disorders. In fact psychoanalysts say that, if properly treated, all cases of mental diseases can be cured with its aid. They further claim that in many cases psychoanalytic method is the only method that can effect a cure. As bonafide psychoanalytic medical practitioners are not very common, and even those that exist are not very wholeheartedly accepted within the folds of the orthodox medical profession, it is difficult to get reliable statistics regarding the efficacy of this method. According to a recent note in the *Scientific American*, Dr. H. T. Hyman of New York made a study of 43 cases of mental patients, who were treated psychoanalytically, for testing this point. Of these, 15 suffered from serious mental troubles. In 12 cases out of these 15, psychoanalysis could not achieve anything. In two cases, the result is still doubtful, while one patient, a homosexual, made a brilliant recovery. The remaining 28 cases were of a less serious nature, *e.g.*, hysteria, anxiety states, obsessions, etc. Of these, 17 cases distinctly improved, while 11 got no positive benefit.

Though the Freudians claim that this method is applicable to patients of all ages, Dr. Hyman has come to the conclusion that successful patients are generally above 25 years and below 40 years of age and should be intelligent, with imagination, and preferably educated. In America the total fee for psychoanalytic treatment averages from 5,000 to 6,000 dollars per case. The average visit costs about 10 dollars and there are likely to be 250—270 sessions a year. It takes about 18 months to 2 years to complete an analysis. Evidently, therefore, it is only the rich who can afford a course of psychoanalytic treatment.

Award of Honorary Degrees

The academic council of the Lucknow University has decided in a recent meeting to confer honorary degree of D. Litt. to Sir J. P. Srivastava, Mr. C. Y. Chintamani, and Rai Rajeshwar Bali, the Minister and ex-Ministers of Education, U. P., at the next convocation.

Agra University

At a recent meeting of the executive council of the Agra University it was decided to award the following doctorates at the next convocation to be held on Nov. 20.

(i) D. Litt. on Mr. Raghubir Singh for his thesis on "Malwa in transition—A century of Anarchy."

(ii) D.Sc. on Mr. Brij Mohan Johri for his thesis on "Morphology of the Absinaceae and Butomaceae."

Training College for Rajputana

At its annual meeting held on October 17, the Rajputana Board of Education has accepted a scheme of establishing a training college at Ajmer. A committee consisting of Mr. J. C. Chatterjee, chairman of the Board, Dr. P. Basu, vice-chancellor, Agra University, and Mr. Owens, director of education, Jaipur State, has been formed to negotiate with the Government of India in this matter. The Board has decided that the college should be located at Ajmer, as Ajmer possesses a training school with excellent grounds and buildings and has five high schools, which will provide facilities for practical training. As there are a large number of schools and intermediate colleges in Rajputana, Central India, Gwalior, and Ajmer Merwara a large number of trained teachers are required in these parts. A training college at Ajmer would therefore serve a useful purpose.

The Board considered the report of the subcommittee appointed to go into the question of suggesting subjects for vocational education and resolved to defer consideration of the matter until the advice of the experts in this branch of education to be appointed by the Governmennt of India was available.

The Board decided to recommend to the Controlling Authority that the States and the British areas under the jurisdiction of the Board be consulted regarding the desirability of establishing an affiliating university for Rajputana, Central India, and Gwalior.

The Board referred certain extracts from the report of the Unemployment Committee, United Provinces, to its Curriculum Committee for consideration.

The Board granted provisional recognition to the Alexandra Jehangiria High School, Bhopal, for its High School examination of 1938 and 1939 on certain conditions.

The Board fixed March 5, 1937, as the date for the commencement of its examinations to be held in 1937.

A Modern Map of India

To many people it will come as a surprise that India still lacks a really modern map. India is of course being mapped continuously since the foundation of the Trigonometric Survey of India in 1818, but maps produced before 1905 were very crude. The modern ideal in map-making everywhere is to have no map which is more than 20 years old. It is however consoling to know that probably no country in the world has realized this ideal in practice. In old maps hills and mountains were indicated merely by *hachures*, but modern maps require a complete contour survey of the country. This is what the Survey of India is now doing.

The work was started in 1905 as a result of a commission which sat to consider the then existing maps of India. It was hoped that the work could be completed within 25 years but owing to the intervention of the war and successive retrenchment campaigns, only 1,25,528 sq. miles out of a total area of 1,884,687 sq. miles (including Burma) have been surveyed till now. Large areas in Central Burma, eastern Bengal, north Bihar, south Bombay, Gujrat, Sind and western Rajputana are still to be mapped on modern lines. It is hoped that even when Burma is separated, the survey work will continue with Burma bearing her share of the cost.

Ten parties of workers are now engaged in this survey work. Nine of these do the actual field work in the winter months and during the rains they do the drawing work. One party which works on the Himalayas is active mainly during the summer, retiring during the rains and winters.

Japan's Educational System

The *Asiatic Review* for October, 1936, contains an account of Japan's educational system by Mr E. H. Anstie which will repay a careful study. We learn from this paper that since 1872, primary education in Japan has been compulsory, and to-day, education in all stages is the business of the State. In fact the author says that to-day, from Kindergarten to University, the child is under official control. In view of the increasing tendency in the Government of India and provincial governments to divest themselves of all responsibility in Education, and concentrate merely on law and order, a short account of the activity of the State in Japan may prove quite instructive. This is shown in a tabular form:—

Institution	Age	Percentage of Students	System
State Mixed Elementary Schools	5-11	99% of children of school going age attend these institutions. All classes, high and low attend these schools.	Co-education
Boy's Middle School	11,12-16,17	17% from elementary schools, taken by competitive examinations.	Morals. Civics Japanese language, Chinese classics, History, Geography, Mathematics, Science, Technical studies, woodwork, a foreign language.

[50% of the students in the Middle Schools do not proceed further]

Institution	Age	Percentage	Syllabus
Boy's Higher School	16, 17	24%	Preparation for the Universities
Boy's Higher Trade and Technical Schools	16, 17—19, 20	24%	Commerce, Engineering, Navigation.
Colleges. 75		50%	Professional study in pharmacy, dentistry etc.
Teachers' Collegs.		2%	For training teachers.
Universities 46	19, 20-22, 23 or 4 years in medicine		Have faculties in arts, sciences, medicine
			Gives the degree of Gakushi, or learned gentleman
	22, 23-24, 25		Post-graduate course in doctor's degree.

Girls' Education after the elementary schools.

Institution	Age	Percentage	System
Girls' High School	11—16	18% of girls from elementary schools	Secondary school type. This marks usually the end of education for girls
Supplementary Course for 1 or 2 years			
Post-Graduate Course			Education brought up to the Standard of Boy's Higher School
Colleges 41			Professional training in music, nursing etc., etc.
Normal schools.			

According to this writer, the results from this system and education are as follows:—

"The completeness of Japan's educational system and the thoroughness with which it is controlled has undoubtedly been a great factor in Japan's rise to the position of a first—rate power. It has given her an educated proletariat and a supply of intelligent and efficient workers for her industries, who are yet content to remain workers and to do their duty in the station of life in which they find themselves. It has given her a population animated by a patriotic single-mindedness which gives tremendous weight and drive to her efforts at expansion."

Curriculum of Medical Studies in the Calcutta University

The Committee appointed by the Calcutta University of Lt. -Col. T. C. Boyd, Dr. B. C. Roy, Lt.-Col. P. Fleming Gow, Dr. M. N. Bose and Dr. S. K. Mukerji, to report on the curriculum of medical studies under the University, has recommended that the curriculum should be divided into two periods, a pre-clinical period (two years) and a clinical period (three years). An examination (the first M. B. examination) should be held at the end of the pre-clinical period, which a student must pass before he is allowed to proceed to the next stage.

At the end of the clinical period an examination (the second M. B. examination) should be held in two parts. Before a student can obtain his M. B. degree he should produce a certificate that he has attended a further six months' course of approved clinical study in a recognized institution.

Admission should be through a specially constituted examination called the "I.Sc. medical" examination. Students who have passed an ordinary I.Sc. examination may be admitted to a medical college after a complete six months' course in those portions of the medical group in which they were deficient and after passing an examination in those portions.

Death of Dr. A. H. Mackenzie

The death has occurred of Dr. A. H. Mackenzie, Pro-Vice-Chancellor of the Osmania University. He entered the Indian Educational Service in 1908, was the Principal of the Government Training College for eleven years, was then made the Director of Public Instruction, U. P., and was also the nominated Vice-Chancellor of the Agra University for one term. He took great pains to organize the primary and vernacular education in the United Provinces, as also the training of teachers, both in primary and secondary schools.

A Reader for the Calcutta University

Dr. Hermann Goetz, Conservator of the Kern Institute, Leyden, has been appointed a special University Reader to deliver a course of lectures on 'The Genesis of Indo-Moslem Civilization' and 'The Crisis of Indian Civilization in the Eighteenth Century."

Public Instruction in Bengal

The report of the Bengal Government on Public Institution in Bengal for the year 1934-35 reveals that though there was a decrease in the number of primary institutions in the year under report, the number of pupils increased. The total number of school pupils attending primary schools was 851,008, the corresponding figure for Muhammadans being 1,044,577, both figures showing a substantial increase on the last year's. 7.5 P.C. of the total Hindu male population and 7.8 P.C. of the Muhammadan male population were receiving primary instruction. The report does not clearly state under what circumstances the number of primary schools fell to 70,241 recognised and 1,419 unrecognized ones, from the last year's figures of 70,838 and 1,588 respectively.

At the secondary stage were 3,194 schools with 480,966 pupils, as compared with 3,170 schools with 468, 060 pupils in the previous year. There were 44 arts colleges for males and 7 for women, with 23,746 pupils, the corresponding figures of last year being 45,6, and 22,427.

Ancient Coins in China

A valuable collection of ancient coins, probably belonging to the T'ang (6th century) and Sung (960-1270) dynasties, has been unearthed by a farmer, while digging a well at Ting-chwang in Hsiang-chen- about 70 miles south of Chenge-how in the Ho-nan province. The find, containing about 3,400 pieces, has been made over to the provincial authorities for exhibition.

Lord Nuffield's Gift to Oxford

In the West, especially in Great Britain and America, magnanimous monetary gifts made by public men to the Universities, and other educational institutions for the development of scientific studies are frequent. The latest well-known gift is that by Lord Nuffield who recently made over a sum of £1,250,000 to the Oxford University for the development of the Nuffield Institute of Medical Research. It is, indeed, impossible to over-estimate, as Sir Kingsley Wood, referring to the donation, recently said, all it would mean not only to research but also to the many improvements in the health of the nation. It is needless to say how we wish such noble examples as set by Lord Nuffield were emulated by other for educational purposes is few and far between and where education stands so badly in need of it.

Financial Position of the Institute of Science

The audited statement of the financial position of the Indian Institute of Science, Bangalore, shows that the total income during 1935-36 was Rs. 5,82,604. The main items under receipts were:—

	Rs.
Bombay Properties	87,916
Treasurer of Charitable Endowments	2,23,375
Government of India	1,50,000
Government of Mysore	30,000
Government of Madras	5,000
Government of Hyderabad	10,000
Government of Central Provinces	1,500
Government of Travancore	3,000
Imperial Council of Agricultural Research (for Biochemical research)	2,592

The expenditure for the year was Rs. 6,57,229, which included items of capital non-recurring nature totalling Rs. 1,04,230. The expenditure during the year thus exceeded the income by Rs. 74,625.

The budget estimates for 1936-37 provide for an income of Rs. 6,01,575 and an expenditure of Rs. 5,73,834, including Rs. 31,000 for capital expenditure.

Conservation of Coal Assets of India

That the present methods of extracting coal are wasteful and are attended by danger to life has been brought out by fires which are, after so many months, still raging in some fields. Sir Lewis Fermor, ex-Director, Geological Survey of India, in his note on India's coal resources published last year, has drawn a pessimistic picture and has uttered a warning. In this connection we would draw the attention of readers to the article 'Conservation of Indian Coal': by Dr .S. K. Ray of Dhanbad, appearing elsewhere in this issue. The Indian coal interests have been averse to a compulsory sand-stowing method advocated by the Coalfields Committee of 1920. It is said that if the Government had been firm on this question and had adopted the principle of statutory conservation in time, the fires witnessed in recent months and the loss to stock of coal would not have been caused.

The Government of India's resolution on this subject shows their concern for the urgent need of conserving the coal assets of this country by improving the methods of extraction and preventing avoidable waste. Though certain emergency steps have been taken towards affording greater protection to the miners with the concurrence of the legislature, yet these are, says the resolution, not likely to prove adequate in future years.

The Government of India have accordingly decided, as already announced in the Legislative Assembly, to appoint a committee of experts to inquire into the methods of extracting coal underground and report on the measures which should be taken (1) to secure the safety of those employed in this work and (2) to prevent avoidable waste of coal.

The personnel of the committee is as follows:—

Chairman—Mr. L. B. Burrows, Commissioner, Burdwan Division; Sir Jehangir Cooverjee Coyajee, professor, Andhra University; Mr. J. Mackie, agent, Eastern Coal Company, Ltd.; Mr. H. K. Nag, agent, Chasuala Coal Company; Mr. N. Barraclough, Inspector of Mines; Dr. M. S. Krishnan, geologist, Geological Survey of India (members); and Mr. M. Ikramullah, secretary.

The committee's inquiry will be limited to the coalfields in Bengal, Bihar and the Central Provinces and its headquarters will be Calcutta. It is expected to assemble about the end of next month.

"In connexion with part (1), the committee are being asked to consider specially (a) the dangers arising from underground fires, (b) dangers arising from collapses and workings and (c) the suitability of explosives in use and of methods of using and storing them.

"In connexion with part (2) the committee are being asked to consider specially (a) the control that should be exercised over mining methods to ensure that a substantial proportion of coal is not rendered incapable of extraction, (b) the extent to which it is desirable and practicable to enforce partial or complete filling of space from which coal is removed by incombustible material, and (c) the manner in which the cost of any action that may be recommended should be met."

The committee will tour the coalfields in Bengal, Bihar and the Central Provinces, will examine the existing methods of extracting coal.

It is reported the committee will start to work from November 1936, and will submit their report which is expected to reach the Government of India some time is March, 1937.

Discovery of New Minerals in India

At a meeting of the Mining and Geological Institute of India, Dr. J. A. Dunn and Dr. A. K. Dey of the Geological Survey of India described certain deposits of iron-ores containing vanadium and titanium in the Singbhum district and the Mayurbhanj State.

The vanadium is contained in a new mineral called 'coulsonite', which has been detected only by the improved techniques now introduced at the Geological Survey Laboratory. Vanadium is used in the manufacture of special steels, in chemistry, in photography, and in the paint, ceramic and glass industries, while titanium is necessary for modern brush and spray lacquers and pigments, in dye industry, in special steels and in compounds used for smoke screens.

Progress of Civil Aviation in India

In the Legislative Assembly, Sir Frank Noyce laid a statement showing the progress of civil aviation in India. A new landing ground at Cuddapah had been completed, work at Mughal Bhim was in progress, landing ground surfaces had been improved, runways completed at Jacobabad, Delhi, Gaya, Akyab and Bassein and improvements were in progress at Chittagong, Dum Dum and Juhu. Work was nearing completion at Karachi, Hyderabad, Allahabad, Cawnpore, Gaya, Calcutta, Akyab, Rangoon and Bombay. Twenty Army landing grounds had been thrown open to civil aircraft subject to certain conditions. There were, in addition, 28 landing grounds in charge of the R. A. F., which had always been open to civil aircraft.

Sir. P. C. Ray's Proposal

We have it from a press report that Sir P. C. Ray has proposed to the Bengal Chemical and Pharmaceutical Works Ltd., of which he is the founder, that it should contribute Rs. 15,000 a year to the Calcutta University and medical institutions of the City for the promotion of scientific investigations, especially physiological research on drugs, and for the creation of a fund to help hospitals. One of his aims, he says, in starting the firm, was to train a body of men in business, the success of which, especially of the one like the Bengal Chemical and Pharmaceutical Works depends to a very large extent on the growth and development of scientific research. German, American, or English firms spend thousands of pounds every year for such purposes. And surely the Bengal Chemical Works can, following their example, devote a fraction of its profits towards these ends.

Dr. B. S. Guha

News has been received that Dr. B. S. Guha, anthropologist to the *Government of India, Zoological* Survey, Calcutta, has been elected a member of the Comité International de preparation Scientifique of the Institute International D'anthropologie. He has also been recently elected a member of the Comité Permanent de Recherches pour la Standardisation des methods anthropologique of the Congrès International Des Sciences anthropologiques and is on the Executive Body of the Section dealing with anthropometry.

Rush for Cheaper Telephones in Great Britain

Following the announcement in the House of Commons by the Post-Master-General of Great Britain on July 13 of considerable reductions in telephone charges with effect from October 1 (See SCIENCE & CULTURE of September 1936, p. 147), about 60,000 applications for telephone connection have been received by the Post Office. The response to the Postmaster-General's announcement has been excellent and this was but expected. The Post Office engineers of Great Britain have been no doubt hard at work keeping pace with the demand, and the loss of revenue due to the reduced charges, estimated to be £1,500,000 annually, is sure to be speedily made good. This is another instance to justify our contention that reductions in charges must precede, and not follow, an increase in the use of public utility services, such as the telephone, electricity, etc., which the supply undertakings refuse persistently to believe in. We can do no better than quote the comments of the *Electrician* on this: "Electricity undertakings, as well as the Post Office, were rather slow to realize that when the public is offered a service that it wants at a price that it can afford, the volume of business to be done exceeds all expectations. Now that the lesson has been learned the limits of development are well beyond the horizon."

Eight New Broadcasting Stations in India

The Government of India have decided to give effect to the recommendations of Mr. H. L. Kirke, head of the research department of the British Broadcasting Corporation, who, after an inquiry, outlined some time ago a scheme for the development of broadcasting in India, and establish eight new transmitting stations in the major provinces. The estimated cost is Rs. 40 lakhs, and the Standing Finance Committee of the Legislative Assembly has approved of the scheme. It provides for one-kilowatt medium-wave stations at Trichinopoly, Decca, Lucknow (or some other suitable place in the U. P.), and Lahore; a five-kilowatt medium or short-wave station at Madras; a five-kilowatt short-wave station in Calcutta; two five-kilowatt short-wave stations at Delhi (one of which is to be transferred subsequently to Bombay when experiments are completed); and a quarter-kilowatt medium-wave transmitter at Peshawar, to be taken over from the North-West Frontier Province Government. In order to make preliminary arrangement at the centres where new stations are to be established the Deputy Controller of Broadcasting in India and the Chief Engineer of the All-India Radio have aheady started on an all-India tour.

Nobel Prize Awards

Nobel Prize awards for 1936 have just been announced. Drs. Hess and Anderson have won the physics prize. The chemistry prize has gone to Professor Debye.

Research Notes

Dihydrothelin from Liquor Folliculi of Sow Ovaries

With the introduction of Allen and Doisy's vaginal smear method for detecting and assaying follicular hormone [application of the smear method originally described by Stockard and Papanicolaow in rabbits: *Amer. J. Anat. 22,* 225, 1917] a new line of investigation into the occurrence and distribution of estrogenic substances was opened, and during the last few years at least half a dozen different compounds have been isolated from the urine of pregnant women and mares.

Using liquor folliculi aspirated from sow ovaries, Doisy et al obtained a preparation having a potency exceeding that of theelin, the hitherto isolated follicular hormone. Effect of semicarbazide on the potency of this unknown hormone was found to be negligent which marked it as a substance entirely different from theelin.

Mac Corquodale, Thayer and Doisy [*J. Biol. Chem. 115,* 435, 1936] have now isolated the new estrogenic substance of liquor folliculi from 4 tons of sow ovaries as pure crystalline di-L-naphthoate of dihydrotheelin and also m-bromobenzoate.

The derivatives were hydrolyzed and the hormone obtained in the pure crystalline condition. Assay by the vaginal smear method shows that dihydrotheelin is more potent than any other known substance in producing cornification in the vagina of the ovariectomized rat or mouse.

One ton of sow ovaries yielded about 6 mg. of the hormone. The estrognic substances of human and mare urine are different. The isolation of dihydrotheelin from sow ovaries, therefore, does not necessarily mean that the ovaries of other species may contain this hormone. Wintersteiner, Schwenk and Whitman [*Proc. Soc. Exp. Biol. and Med., 32,* 1087, 1935] however reported the isolation of the same substance and its isomeric form from the urine of pregnant mares.

H. N. B.

Copper as a supplement to Iron in Hemoglobin formation

Schultze, Elvehjem and Hart [*J. Biol. Chem. 106,* 735, 1934] reported that copper of copper caseinate, glycine amide biuret, alanine amide biuret, hemocyanin and of whole wheat was readily utilized by severely anemic rats to supplement iron for hemoglobin formation, whereas the copper of copper hematoporphyrin was not available even when fed at high levels. This indicates that copper may exist in a form which cannot be utilized by the animal and that possibly animal and plant tissues might contain at least some of the copper in unavailable form. By extending the work further the same authors [*J. Biol. Chem. 115,* 453, 1936] find that the copper of wheat germ, alfalfa, brewers' yeast, pork heart, pork liver, cysteine cuprous mercaptide, copper aspartate, copper citrate, copper nucleinate, copper pyrophosphate is readily utilized by severely anemic rats to supplement iron for hemoglobin formation.

The authors are of opinion that the formation in the intestinal tract of copper complexes by proteins or their digestion products does not interfere with absorption of copper. Besides copper-porphyrin, the only copper compound which has been found to be a poor source of copper is CuS. Under certain conditions the formation in the digestive tract and the unavailability of CuS may have to be considered as a factor in decreasing the utilization of dietary copper.

H. N. B.

On the discovery of the earliest Brahmanical Wall Paintings in India

In a very important communication entitled "A celestial betrothal in a sixth century Indian wall painting" (*Illustrated London News,* August 8, 1936, p. 249, 1 plate) Dr. Stella Kramrisch of the

University of Calcutta reports her discovery of the wall paintings in Cave No. III at Badami in Kaladgi Collectorate in the Deccan. The scene enacted in one such wall painting has been identified as that of the marriage of Śiva and Pârvatî (plate). According to her opinion there is a considerable similarity between the later work at Ajanta and the Badami paintings. She has also remarked that "whereas the walls of the cave were not sculptured, they were covered with paintings. Moreover, the sculptures were altogether painted and the same colours were used for both." Regarding the age of this painting she holds that as this cave has an inscription of Mangaleśa dated *Śaka* 500, this painting should also be dated *Śaka* 500. The present reviewer believes that the age of this painting may be fixed with greater accuracy. The inscription which Dr. Kramrisch has referred to is dated *Śaka* 500 and of the Western Châlukya king Mangaleśa, of the 12th year of the reign (of his elder brother Kîrtivarman). (*Epigraphia Indica,* Vol. VII-appendix, notice No. 3, 1902-03). The object of this inscription is to be record that Mangaleśa constructed or completed the cave as a temple of the god Vishnu. As this inscription is deatd in *Śaka* 500 which is equivalent to the 12th regnal year of Kîrtivarman I and as all the religious merits for this construction were to go to Kîrtivarman I, we may rightly conclude that the work of this construction was completed within the period ranging from *Śaka* 489 (i.e., 500 *minus* 11) to *Śaka* 500. Therefore this painting might be dated within the period ranging from *Śaka* 489 to *Śaka* 500. Dr. Kramrisch has further noted that there are several other portions of paintings in this cave as well as in Cave No. II. It is fervently hoped that all these paintings would be more thoroughly studied by her.

C. C. Das Gupta.

Cultural Associations between India and Babylonia

It is reported in the latest issue of *The Illustrated London News* (12th Sept. 1936) that Prof. H. Frankfort, the Director of the Iraq Expedition of the Oriental Institute of the University of Chicago, has recently discovered at Tell Agrab in Mesopotamia a pre-Sargonic site belonging to the earliest part of the Early Dynastic period. Here he found a temple made of plano-convex bricks surrounded on three sides by higher mounds containing house ruins. The temple consists of three sanctuaries and the most important one contains an unusually high altar with double rows of square offering tables in front of it. Large numbers of amulets of various shapes made of bone and shell, and stone statues of devotees were found. The latter represent the worshippers who seemed to be permanently in presence of their god. Beautiful sculptured stone vases and about 400 mace heads of various shapes were found. The most remarkable of these finds are two fragments of a cylindrical vase of green steatite having the conventional rendering of a wattle-and-daub structure and such a fragment has also been found at Mohenjodaro. In one of the above two fragments there is a human figure with distinctive Sumerian features and in the other there is a large humped bull standing in front of the manger. The wild ox and the water buffalo were indigenous to Mesopotamia but the humped bull was not. Such humped bull are very common in the Indus Valley seals. Occasional signs of intercourse between Mesopotamia and India have so far been explained as a result of intermittent trade or contact but now for the first time we have found the rendering of an Indian cult in an entirely Mesopotamian setting. Dr. Frankfort finds an explanation of this in Sir Aurel Stein's work in Persia. It appears certain that at about 3000 B.C. the regions separating India and Mesopotamia were much less arid than they are now and a distinct cultural continuum and not merely the intermittent contact due to trade relations by the sea-route was present between these places. As purely Mesopotamian types of vases mostly prevail and though they are found in a temple of the Early Dynastic Period, Prof. Frankfort thinks them to be "almost certainly heirlooms from an earlier temple," which he expects to excavate this winter.

S. S. Sarkar.

University and Academy News

National Institute of Sciences of India

At a meeting of the Council of the National Institute of Sciences of India held in the rooms of the Royal Asiatic Society of Bengal, 1, Park Street, Calcutta, on the 8th October, 1936, the following gentlemen were duly elected Fellows of the Institute.

Ordinary Fellows.

Mr. W. E. V. Abraham.
Prof. Jyotirmaya Ghosh.
Dr. D. S. Kothari.
Mr. J. P. Mills.
Prof. Punchanan Neogi.
Mr. G. E. Parkinson.
Dr. F. G. Percival.
Dr. B.N. Prasad.
Lt.-Col. R. B. Seymour Sewell.
Lt.-Col. H. E. Shortt.

Ordinary Fellow elected under Regulation 12.
Dr. Satya Churn Law.

Honorary Fellows

Prof. F. G. Donnan.
Prof. Albert Heim.
Sir Arthur Keith.
Sir Albert Seward.

Indian Chemical Society

A meeting of the Indian Chemical Society was held on Thursday the 1st October at 5-30 p.m. in the Chemical Lecture Theatre of the University College of Science, Sir U. N. Brahmachari, Kt. M.A., M.D., Ph.D., F.A.S.B., F.I.N. etc.—the President of the Society presided, Prof. Dr. J. B. Niedert of the University of New York, who is on a world tour, delivered an interesting address on the teaching and technique of Micro-chemistry with special reference to organic branch of the subject. The lecture was illustrated by lantern slides. A large body of chemists from different institutions, besides the Fellows of the Society, attended.

The importance and usefulness of micro-analytical methods leading to a great economy of time, material, money, space and equipment was emphasized by the speaker. He further gave an account of its rapid spread and development in America.

The President at the close of the meeting offered, on behalf of the Indian Chemical Society and the University of Calcutta, his best thanks to the guest of the evening.

Calcutta Mathematical Society

An ordinary meeting of the Calcutta Mathemaitcal Society was held in the Society's room, on Sunday, the 27th September, 1936 at 5 p.m.

(1) The following gentlemen were proposed for election as ordinary members of the Society:

(a) Mr. H. N. Gangully, M.A. (Patna)

(b) Mr. N. Chatterjee, M.A. (Bankipur)

(2) The following papers were read:—

(a) N. N. Ghosh:—"On linear subspace in Euclidean Hyperspaces."

(b) D. Basu:—"The effect of finite breadth of hammer striking a Pianoforte string."

(c) S. N. Roy:—"On the vector derivation of Invariants and centroid formulae for Convex Surfaces."

Book Review

Indian Chamber of Commerce, Calcutta—Annual Report for the year 1935,—*Published by M. T. Gandhi, Secretary, Indian Chamber of Commerce Calcutta Pages Liii + 339 + 28.*

We have perused with considerable interest the Annual Report of the Indian Chamber of Commerce for the year 1935, a copy of which has been lying on our table for some time. The chamber is going ahead with its activities, and taking its due share in forming and focussing Indian public opinion on important commercial questions. It is not possible to mention here even the names of all the subjects that engaged the attention of the Chamber last year. Questions relating to railway freight, tariff classification, port facilities, position of India's trade and industries, labour legislation are only some among the many which were referred to the Chamber for expression of opinion, and the Report embodies the considered views of the section of the Indian commercial community as represented in the Chamber on these various subjects. We congratulate the Chamber on its brilliant record of activities which have also, we are glad to note, receiver its due recognition from the Government. The Chamber has been given representation on various public bodies like the Calcutta Port Trust, the local Advisory Committees of the three Calcutta Railways, etc., and the Report under review records the attempts made for securing a due representation on the reformed Legislatures, both Provincial and Central. We understand that its efforts in this direction have also been successful, for which we again offer our congratulations to the Chamber.

S. R. B.

Indian Journal of Venereal Diseases—*E y U. B. Narayan Rao, Published quarterly at 94, 97 Girgaum Road, Bombay 4; Rs. 5/- Annually.*

Venereal diseases cause untold misery among mankind and they are a dreadful menance to civilization. But unfortunately they do not receive as much attention as their terrible consequences would demand, due mainly to the lack of scientific knowledge about them on the part of the public which persistently fails either to realize or to admit the grave dangers involved in them. The West ~~has lately awakened to the seriousness of the~~ problem, and is trying hard to fight the evil of these diseases. In America and Europe rapid strides have already been made towards the cure and prevention of many of the venereal diseases, and the progress of scientific investigations into them, as revealed by the amount of work put in by these countries, is by no means inconsiderable. But what is urgently needed at present, in order that the evils of the diseases may be successfully combated is the dissemination of the latest knowledge about them, attained by scientific investigations, among the general public, so that it may learn to make the best use of such knowledge. In India comparatively very little has been done in these directions, and hence the recent appearance of the *Indian Journal of Venereal Diseases* is very welcome. It is a quarterly journal, devoted purely to venereal diseases and allied subjects, and has to its credit an international board of editorial collaborators. Seven issues have been published up to date. It aims at giving the results of the latest researches in venereal diseases and up-to-date information about them. Original articles from the pen of scientific workers in these fields, both technical and semipopular in nature, are published, and each subject is dealt with by a wellknown specialist. Suitable gleanings from contemporary journals regarding the latest work form one of its regular features. It also gives authoritative short accounts (statistical and otherwise) of what is being done in other countries in repect of the prevention and cure of venereal diseases. A journal of this kind was long needed in India, and the editors are to be congratulated on their laudable venture.

M. S. C.

Letters to the Editor

Diffraction of Electrons through thin Films of Celluloid

Just after the historic experiment of Davisson and Germer[1] on the diffraction of electrons by single crystal of nickel showing the evidence for the wave nature of the electrons, A. Reid[2] tried to diffract electrons by thin films at the suggestion of G. P. Thomson. The pattern formed by the impact of the rays on the plate consisted of an intense central spot due to unscattered rays, surrounded by one or more rings with the main beam for their centre. Their final results showed three rings for each of which the diameter D and the voltage P were connected by the law $D\sqrt{P} =$ constant. This is, of course, a necessary result in any diffraction pattern formed by de Broglie waves, if relativity correction is neglected. The wavelength required was of the right order to fit de Broglie's formula. A final account appeared[3] later clearing certain points of difficulty. The ratio $D_1 : D_2$ is almost 1 : 2, that of $D_1 : D_3$ is about 1 : 3, which led them to conclude that the rings are three successive orders. The experiments of Reid were only of a qualitative nature showing only the wave nature of the electrons and verifying de Broglie's formula.

The results of the present author on similar experiments have shown that there are four rings and not three as observed by Reid and that the rings are due to different Bragg spacings. The rings are very broad and diffuse. Measurements are however made at the centre of the blackening of each ring. As regards the fourth ring, measurement is not very reliable, as the ring is very faint. With the increase of voltage, the breadth of the ring appears to decrease as seen from the following table.

Voltage.	D_1 mm	D_2 mm	D_3 mm	D_4 mm	$D_1\sqrt{P}$	$D_2\sqrt{P}$	$D_3\sqrt{P}$	$D_4\sqrt{P}$
23500	9.2	17	28.2	—	44.6	82.4	136.7	—
25000	9	16.2	26.8	—	45	81	134	—
28000	8.6	15.2	25.6	40.4	45.5	81	135.6	214

The spacings '*d*' were measured according to Bragg relation

$$n\lambda = 2d \sin\theta$$

Since θ is the order of 1° we can write $\sin\theta = \theta$. Thus if L be the distance of the plate from the scattering film and D be the diameter of the rings we can write

$$d = \frac{2L\lambda}{D}$$

The values of d are found to be 4.04 Å, 2.23 Å, 1.34 Å and 0.85 Å for the four rings respectively.

Khaira Laboratory of Physics,
University College of Science,
Calcutta.

S. Chaudhuri.

1. *Phys. Rev.*, *30*, 707, 1927.
2. G. P. Thomson and A. Reid, *Nature*, *119*, 890, 1927.
3. A. Reid, *Proc. Roy. Soc.* London, *A119*, 663, 1928.

A Possible Process of Absorption of Wireless Waves

It is usually assumed that the only important process involved in the absorption of an electromagnetic wave (wireless wave) traversing an ionized atmosphere is that of collisions between the free electrons and atoms or molecules. The free electrons abstract energy from the wave, and on collision with an atom or a molecule this energy changes into heat. The purpose of this note is to point out the possible significance of another process in the absorption of wireless waves. This process consists in that a free electron moving under the Coulomb field of an ion and under the influence of an electromagnetic field due to the waves performs a transition from an initial hyperbolic orbit of energy, say E_1, to a final hyperbolic orbit of energy, say E_2, where $E_2 - E_1 = h\nu$, ν being the frequency of the electromagnetic waves. This is called "Free-free transition" in the ususal theory of the absorption of electromagnetic waves due to Kramers and Gaunt. These investigators have made use of the theory to account for the absorption of X-rays. We here attempt to extend the same theory to wireless waves. Gaunt has shown that the transitional probability of absorption a_0 (E,ν), for an electron of initial energy E_1 to undergo transition to an orbit of energy E_2, when moving in the Coulomb field of an ion (singly charged) and subject to a beam of radiation of unit intensity, is

LETTERS TO THE EDITOR

$$a_0(E_1,\nu) = \frac{4\pi z^2 e^6}{3\sqrt{6} h c m^{3/2} \nu^3 \epsilon^{1/2}} g$$

$$\text{where} \quad g = \frac{\sqrt{3}}{\pi} \log \left(\frac{E}{h\nu}\right),$$

If T is the temperature of the ionized medium, and N be the number of systems per unit volume—by a system we mean a free electron associated with an ion in whose Coulomb field the electron is moving—then the absorption coefficient will as usual be given by

$$k = a_0\ (E_1, \nu).\ N.$$

Substituting numerical values and taking $T = 1000°$K (which, according to Appleton, is the temperature of the F-region); $\nu = 10^6$ per sec., and assuming N to be of the order of 10^6, k is of the order of $9{\cdot}52 \times 10^{-6}$ per cm. This shows that the above process of free transition may prove to be of importance in the absorption of wireless waves.

Vidya Bhawan,
Udaipur.
20.9.36.

Duleh Sinha Kothari.

Vitamin B-content of a few Samples of Bengal Rice

As rice forms the staple food of our countrymen it is of interest to find the Vitamin B_1 and B_2 content of this article of dietary. It is desirable to find at the same time if any variation of B-content exists between varieties of rice as also between rice made under different sets of conditions from paddy. With this object in view the following feeding experiments have been carried out.

Method—For the estimation of Vitamin B_1 and B_2 the biological method of assay with young rats as modified by Guha and Chakravorty[1] was followed.

In the following experiments 5 rats of each group deficient in Vitamin B_1 and B_2 respectively were fed with 2 grams of rice of each sample for 3 weeks and their average weekly growth was determined.

(1) The feeding of the country-made (*dhenki*-rice), parboiled *aus* rice, locally known as *kalabakri* (paddy with black outer coating), to B_1-deficient rats produced an average weekly growth of 6.3 g.

The same rice fed to the B_2-deficient rats produced an average weekly growth of 6.4. g.

Or 100 g of rice contained 31.5 units of B_1
" " 32.2 " B_2
(as defined by Guha & Chakravorty[2]).

(2) The feeding of the countrymade parboiled *aman* rice locally known as *Rangabadal* (paddy with red outer coating) produced to B_1-deficient rats an average weekly growth of 8.3 g.

The same rice fed to the B_2-deficient rats produced an average weekly growth of 6.1 g.

Or 100 g of the rice contained 41.5 units of B_1
" " " 30.4 " B_2

(2*a*) The feeding of the country-made, sundried (*atap*) rice of the *aman* variety just mentioned to the B_1-deficient rats produced an average weekly growth of 2.9 g.

The same rice fed to the B_2-deficient rats gave weekly growth of 2.2 g.

Or 100 g of the rice contained 14.5 units of B_1
" " " 11 " B_2

(3) The feeding of the parboiled mill-made polished *aman* rice to the B_1-deficient rats produced an average weekly growth of 4.7 g.

The feeding of the same to the B_2-deficient rats produced an average weekly growth of 4 g.

Or 100 g of the rice contained 23.8 units of B_1
" " 20 " B_2

The foregoing results point to the fact that the parboiled rice is richer in Vitamin B than the sundried (*atap*) rice and again the *aman* variety contains more B-vitamins than the *aus* one. The results are in agreement with the findings of Aykroid[3].

My sincere thanks are due to Mr. T. Majumdar for supplying me with the samples of home-made rice and also to the authorities of the firm for their constant help and encouragement.

Biochemical laboratory,
Bengal Chemical &
Pharmaceutical Works, Ltd.
Calcutta. 22.9.36

H. G. Biswas.

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1. *Indian Journ. Med. Res.*, *20*, 1045.
2. *Ibid*, *21*, 221.
3. *J. Hyg.*, *32*, 184.

Migration of Hæmolysin and Neurotoxin of Cobra Venom at Different pH in an Electrical Field

The hæmolysin and the neurotoxin are the two important toxic constituents of cobra venom. Although they have never been obtained in a pure state yet they are believed to be nitrogenous organic substances resembling the proteins in their chemical properties. Since proteins possess characteristic iso-electric points, experiments were undertaken to determine the iso-electric points of these toxins. The apparatus used consisted of a three-chambered glass cell, the middle chamber being separated from the two side chambers by diaphragms of parchment paper. The cobra venom solution, the pH of which was previously adjusted to the requisite value, was placed in the middle chamber, and the two side chambers were filled with buffered solutions having the same pH as that of the solution in the middle chamber. The side chambers were connected by agar bridges with two beakers filled with copper sulphate solution and fitted with copper electrodes. The electrodes were connected with the 220 volt lighting circuit and the experiment was conducted at 5°C inside a refrigerator. The quantity of electricity passed through the cell was kept constant in all the experiments. It has been observed that the hæmolysin as well as the neurotoxin migrate to the cathode within the range of pH 3.0 to pH 10.0. This observation leads to the following conclusions :—

(1) The hæmolysin and the neurotoxin can pass through membranes of parchment paper and hence their particle size is smaller than that of albumin or globulin.

(2) They are both fairly strongly basic in character.

(3) They can be separated from other proteins such as albumin and globulin by electrodialysis.

Further work on this line is in progress.

University College of Science & Technology. B. N. Ghosh.
Calcutta, S. S. De.
3.10.1936

Can Electrons enter the Nucleus

A number of experiments have been performed of late to find out whether high energy electrons can be made to enter the nucleus, but with no definite result. The maximum potential so far applied has been 800 K Volts (See *Phys. Rev*, 1935). The failure of these experiments is not difficult to understand, as the de-Broglie wavelength is nearly 100 times larger than the diameter of the nucleus.

But from these experiments, it is not safe to assume that the electron can never enter the nucleus. In fact, the uncertainty principle enables us to find out the energy which the electron must have in order that it may enter the nucleus: if we wish to accommodate a particle in a space of dimension 'l', the uncertainty in its momentum is given by

$$\Delta p \text{ nearly } = \frac{h}{l}$$

Putting $l = a\ 10^{-13}$ cm (dimension of the nucleus)

We have Δp nearly $= \dfrac{h}{a\ 10^{-13}}$

$$\text{nearly } = \frac{6{\cdot}54}{a}\ 10^{-14} \text{ gm} \times \text{cm}.$$

Now $\Delta p < < p < < mc$, where m is the relativity-mass of the electron. We have therefore

$$mc > > \frac{6{\cdot}54}{a}\ 10^{-14} \text{ gm} \times \text{cm or } \frac{m}{m_0} > > \frac{2{\cdot}4}{a} 10^{3}$$

Taking a nearly $=$ 2·4 (diameter of the N-nucleus), we find that electrons can enter the nucleus if

$\dfrac{m}{m_0}$ nearly $= 10^4$, *i.e.*, the energy is nearly $5{\cdot}10^9$ e volts. Now electrons of such high velocity are found in cosmic rays and it can be easily shown that in course of their passage through the atmosphere a good fraction of them must suffer nuclear collisions. The number of such collisions can be easily calculated. It is given by

$$\pi a^2\ (10^{-13})^2 \times 3{\cdot}8 \times 10^9 \times x = 1{\cdot}8 \times 10^{-6} x,$$

where x is the equivalent height of the atmosphere through which the electron has passed. Even at a height of 30 Km, the electron, at vertical coincidence, has passed through 65 meters of air, *i.e*, suffered $1{\cdot}17 \times 10^{-2}$ nuclear collisions *i.e.*, one electron in a hundred suffers a nuclear collision—on the sea level, the number of nuclear collisions would be about 1·5, *i.e.*, even at a height where the pressure is $\frac{1}{2}$ the atmospheric pressure (5 kms), the primary electron must have passed through the nucleus. This incident cannot be without influence on the general cosmic ray phenomenon.

The effect of the entry on the nucleus would probably be to explode the nucleus, and give rise to secondaries.

15.8.1936 **M. N. Saha.**

A brilliant Fire-ball passes over Hyderabad Deccan

On October 13th at 7.33 p. m. (Indian Standard Time), hundreds of people in the City and suburbs of Hyderabad and the surrounding country saw a dazzlingly bright meteor flash out in the eastern part of the sky.

I was in my study-room at the time and saw a flood of bluish-green light burst through a window facing due east. At once I conjectured that it was due to a fire-ball, but by the time I ran into the open air, it had disappeared. I waited to hear the sound of the explosion in air that accompanied this flash. After 7 minutes a loud report was heard like that of a distant gun.

From the information obtained on the following day, by interviewing a number of eye-witnesses, among whom may be mentioned Dr. Abdul Haq and Mr. Mahmood Ahmad

Khan, members of the Osmania University staff, it would appear that the meteor started from a point in the constellation Pegasus, and, pursuing a south-westerly path low down in the air, disappeared towards Pavo.

Being in my study at the time I could not personally observe the path taken by the meteor. Luckily, Mr. Bhaskaran Shastri, Director Nizamiah Observatory, and his Assistant Mr. Bappu happened to be in the verandah of the observatory at the time and could definitely locate the course of the meteor. In the letter Mr. Shastri wrote to me on the 17th, he says that the path of the fire-ball commenced at a point R. A. 23 h. 5 m., Declination 10° N. and ended behind a cloud in the constellation Sagittarius at about R. A. 19 h. Declination 30° South. The approximate path deduced from the accounts of non-technical eye-witnesses agrees tolerably well with the definite data received from Mr. Shastri. It appears further from Mr. Shastri's letter that the fire-ball lasted for 3 or 4 seconds and its brightness after the first second was about that of the full moon.

The light as seen from my study-window was so intense that my garden was brightly, though momentarily, lit up. An observer, who happened to witness the phenomenon from near my garden, states that while the meteor was rushing along its path in the air he heard a peculiar noise somewhat resembling the swish of a whip—a highly interesting fact often reported by fire-ball observers, much discussed by astronomers and physicists, but still awaiting a satisfactory explanation.

The meteor is reported to have thrown out several reddish fragments at the time of its explosion. I motored on the 15th to Falaknumah, Nagal bandah, Gaggan Pahar, etc., to trace some of these fragments, and again on the 18th past Golconda fort and Heniayat Sagar, in the hilly country near Chil Pahar and Shamsabad—a tour of over 90 miles on the whole. I am not yet in a position to report any finds, though some very interesting facts have been ascertained.

According to an observer living beyond the Falaknumah hill, the streak of the meteor lasted for over 10 minutes. This is by no means strange, as some trained observers have witnessed occasionally streaks persisting for more than half an hour.

Mr. Mir Talif Ali of the Hyderabad finance department stated that he was seated in the open air in his compound (near Golconda), close to a mango tree. Soon after the fire-ball appeared, he and a number of other persons nearby heard distinctly the sound of a shower of fine sand beating against the leaves of the tree. A similar sound was heard by the inmates of another house in the neighbourhood, as if fine grains of sand fell on the leaves of an almond tree in their compound. There can be no doubt about the fall of such fine dust from the bursting of a fire-ball. But attempts to pick up some of this cosmic material completely failed—no wonder because the particles must have been exceedingly fine.

Inquiries made at the Mennenite Brethren's Mission, Shamsabad (some 13 miles from the Hyderabad city), led to the conclusion that the main body of the meteor disappeared behind the village of Rallaguda some 5 miles from the Mission grounds. Mr. D. Franz Joshua, Superintendent of the Mission School, said that he was cycling near the 9th milestone from the city on his way back to the Mission, when he saw the fire-ball burst. His eye-sight was momentarily dazzled, but he could just notice a fragment detach and shoot out in an easterly direction.

Communication from more distant places under the track of the meteor is being awaited, with a view to recover some of the fragments that have been reported to have fallen.

Begumpet,
Deccan, N. S. R. Mohd. A. R. Khan.
22.10.1936

A Note on the Analytical Constants of Indian and Foreign Rosins

Amongst the raw materials for soap manufacture rosins also find a place both on account of their cheapness as also on account of their washing properties. In washing soaps, they are used to the extent of 20% while in toilet soaps the use of rosins is allowed to the extent of 2-3% as their presence is considered as a safe guard against rancidity. Bergell. (21 sche. der *Deutsche Oele und Fett Industrie* 1925; p. 233) recommends 2-3 p. c. rosin to the soap as it prolongs or prevents rancidity in soap. It appears that the rosin acts as protective colloid for the liberated free fatty acids and thus prevents their oxidation.

Rosins used in India are either locally manufactured at

(I) Clutterbuckganj (U. P.) and

(II) Jallo (Punjab) from the Himalayan Pines (Pinus Longifolia) or

(III) Imported from foreign countries (generally sold as American).

In the scientific literature, there is no mention of the analytical constants of the Indian rosins. Hence it was considered worth while to find out these constants of Indian rosins and find out how they compare, with foreign Rosin.

For our work, the following varieties of Rosins have been selected.

American rosin (yellow) (Imported variety).
Indian Black rosin (from Clutterbuckgaj).
Indian W. W. rosin (from Clutterbuckganj).

In all these determinations the usual methods[1] of analysis were employed. In the determination of saponification and acid values, particularly, great trouble was experienced due to a very dark colour imparted to the solutions by the Indian rosins. Due to this dark colour (with phenolphthalein, the indicator recommended), the colour change could not be noticed properly and the end point was difficult to identify. In view of this difficulty, the following indicators were tried.

(*a*) Thymolphthalein (1% alcoholic solution)

(*b*) Alkali Blau 6B (1% alcoholic solution)

In the case of thymolphthalein (blue in presence of alkali and colourless in acidic or neutral solutions), the colour change could not be easily marked though it was slightly better than phenolphthalein.

Our experience is that Alkali Blau 6 B (Blue in neutral and acidic solutions and red in alkaline) gives the most satisfactory results.

The analytical constants of the rosins, as obtained by us are given in Table No I. All the values are the average of three readings. Table No. II. gives the analytical constant of foreign rosins (Kolophonium) and these constants have been taken from ***Kohlenwasserstoffoele und Fette:*** Holde and Bleyberg (7th Edition. 1933. Published by Julius Springer, Berlin) p. 924-925.

TABLE I.

Analytical Constants	American Rosin	Indian Black Rosin	Indian W. W. Rosin
Melting point	110-112°C	98-101°C	106-108°C
Saponification value	178	180	186
Acid value	123.57	129.45	134.1
Ester value	54.43	50.55	51.9
Iodine value (Hanus)	185.60	141.7	141.5

TABLE II.

Softening point		70°c
Melting point	upto	130°c
Saponification value		165-200
Acid value		140-185
Ester value		8-35
Iodine value		100-200

Dept. of Industrial Chemistry,
Benares Hindu University.

N. N. Godbole
P. D. Srivastava.

(1) ***Einheit-liche Unnter-Suchungs-Methoden fuerdie Fett-und Wachs-industrie:*** Wizoff.
1930 Stuttgart; Wissenschaft liche Verlags; G. M. B. H.

A Note on the Embryosac- and Embryo-development of *Holoptelea integrifolia* Planch

Holoptelea integrifolia is quite a common deciduous road-side tree, often also found in gardens and villages, in most parts of India. Defoliation takes place about February. The trees remain shorn of their foliage for quite a long time. The new leaves appear during March and April after flowering. During the interval flowers, which are hermaphrodite or polygamous and arranged in fascicles, continue to develop. The fruit is a dry indehiscent samara.

The development of the female gametophyte and of the embryo has been studied. The former, in addition to the customary course of development, shows some interesting anomalies. This note records the principal features of this study.

1. *Embryosac-development:* The normal embryosacs develop in the usual way. The archesporium is hypodermal (fig. 1). It cuts off a parietal cell (fig. 2) whose subsequent divisions produce quite an extensive tissue resulting in the primary sporogenous cell becoming deeply placed (fig. 3). A linear tetrad of megaspores is developed of which the lowermost functions (fig. 4).

This megaspore, after the three customary divisions, produces an 8-nucleate embryosac (fig. 5. 6. 7). The mature embryosac has a somewhat obovate shape. The egg-apparatus lies in the broader micropylar part. The synergids are pear-shaped or flask-shaped with elongated necks, in the granular protoplasm of which the nuclei are situated. No filiform apparatus could be made out. The big broad basal portion is occupied by vacuoles. The pear-shaped egg is bigger than usual: its broad basal portion contains the protoplasm and the nucleus. The upper part is, as usual, vacuolate. (fig. 8).

The chalazal part of the embroysac suddenly narrows into a blunt tail. In this the antipodals are lodged. Their number is commonly more than three. The cells are glandular-looking, and there may be both uninucleate and multinucleate cells in the constituents of the same group. They are persistent (fig. 8).

In the mature embryosac there is a single polar nucleus, evidently arising from the fusion of two. This is situated nearer the egg-apparatus. The actual fusion of the two polar nuclei has not yet been observed.

Among the several anomalies noted are the following:—

1. Absence of polarity, the nuclei being distributed through the entire sac (fig. 9).

2. Want of differentiation among the constituents of the sac: sometimes, however, a cell looking like an egg can be made out.

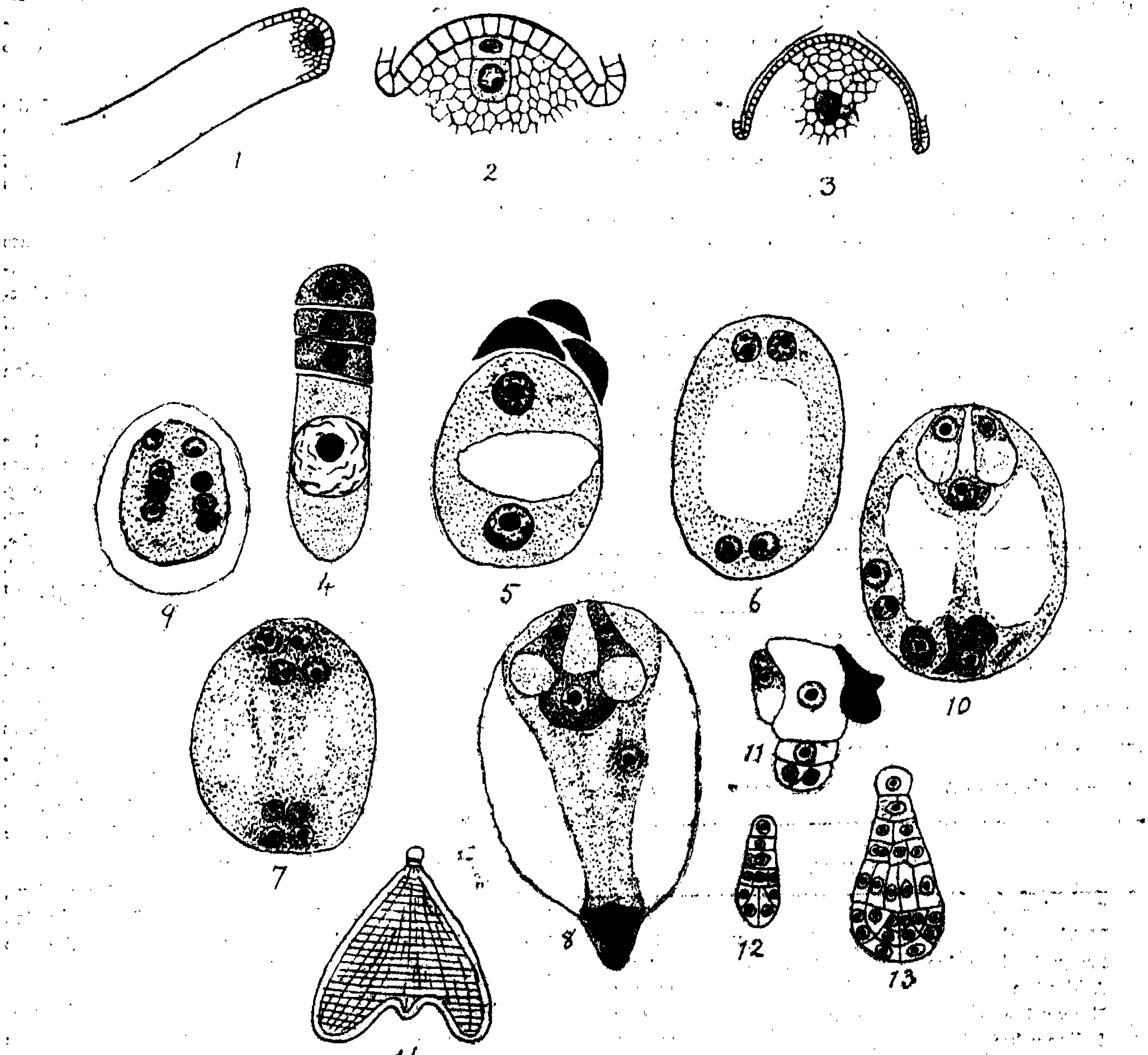
3. More than 8 nuclei are sometimes found in a sac.

4. In some sacs the evidently polar nuclei lie parietally in the neighbourhood of the anipodals. (fig. 10).

5. Presence of less than 8 (*e. g.*, 6) nuclei.

6. In the bipolar sacs want of differentiation in and reduced number of the constituents of the egg-apparatus.

Besides the above, certain other minor irregularities have also been noticed. These will be included in the full account shortly to be published. Without, therefore, entering into details, it may be indicated that abnormalities of a similar nature have been reported before in other plants*. Those in the allied plant *Ulmus americana* reported by Shattuck particularly offer interesting parallel.



2. *Development of the embryo:* This does not offer many special features. The egg divides by a transverse wall into an enlarged basal cell and a small apical one, which divides again. Thus a three-celled proembryo is formed. The apical cell of this divides to produce the embryo. The details of the sequence of wall-formation are being studied. An elongated suspensor is not developed. It is represented by two cells, one of which is the enlarged persistent basal cell. The developmental stages are represented by fig. 11-14.

The actual fertilization of the egg has not yet been observed.

Benares Hindu University. N. K. Tiwary.
20. 9. 1936.

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* Schnarf, K. *Embryologie der Angiospermen*, 1929. p. 176 ff.

Absorption in the Ionosphere

The magneto-ionic theory of propagation of radio waves in the upper atmosphere has been developed by Appleton[1] and others, and more recently Booker[2] has given an interesting exposition of the problem. The dispersion equation for the vertical propagation of radio waves can be easily derived by generalizing Lorentz's treatment, and the complex refractive index is found to be

$$c^2q^2 = \left(\mu - \frac{ick}{p}\right)^2 - 1$$

$$+\frac{1}{(\alpha+i\beta) - \dfrac{\gamma_T{}^2}{2(1+\alpha+i\beta)} \pm \sqrt{\dfrac{\gamma_T{}^4}{4(1+\alpha+i\beta)^2} + \gamma_L{}^2}} \quad \ldots\ldots(1)$$

For definition of the terms see *Proc. Nat. Inst. Sc. of India* Vol. 1, p. 139, 'Report on the Present State of our Knowledge of Upper Atmosphere' by Prof. S. K. Mitra).

The conditions of reflection for the ordinary and the extraordinary rays (henceforth called the o- and the e- rays) are obtained by taking respectively the positive and the negative signs before the radical and putting c^2q^2 equal to zero.

For the absorption of the radio waves, the ionosphere may be divided into (1) a deviating region, where μ approaches zero, and (2) a non-deviating region, where μ is nearly equal to unity. Following Booker it can be easily shown from equation (1) that for the deviating region R the ratio of the integrated absorption coefficients per unit path for the e-ray and the o-ray is given by

$$R = \frac{\alpha}{\alpha - |\gamma_L|} = \frac{p}{p + |p_L|} \quad \ldots \quad (2)$$

For the non-deviating region R', the ratio of the absorption coefficients for the e-ray and the o-ray at the same height is given by

$$R' = \frac{(\alpha + |\gamma_L|)^2 + \beta^2}{(\alpha - |\gamma_L|)^2 + \beta^2} = \frac{(p - |p_L|)^2 + \nu^2}{(p + |p_L|)^2 + \nu^2} \quad \ldots \quad (3)$$

By using a different form of equation (1) Booker has obtained the following two equations in place of equations (2) and (3): –

$$R = \frac{p}{p - |p_L|} \quad \ldots \quad \ldots \quad (4)$$

$$R' = \frac{(p + |p_L|)^2 + \nu^2}{(p - |p_L|)^2 + \nu^2} \quad \ldots \quad \ldots \quad (5)$$

Thus according to the calculations given above the absorption of the e-ray is less than the o-ray, while according to Booker reverse is the case (the present view is supported by experimental observations of Eckersley: *Nature* Vol. 130, p. 398, 1932).

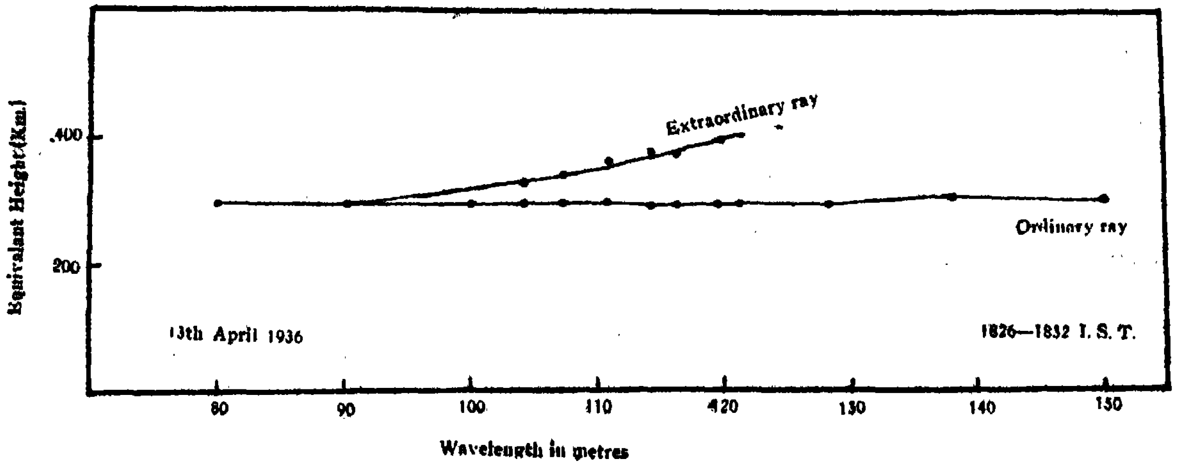
The maximum absorption in the non-deviating region for the e-ray and the o-ray will take place at heights corresponding to $\nu = p + |p_L|$ and $\nu = p - |p_L|$ respectively. This shows that the range of integration for the calculation of the total absorption for the e-ray is much greater than for the o-ray. This naturally results in the greater absorption of the e-ray when there is greater ionization in the regions below the deviating region. But when the ionization in the lower regions is small, and the group path in the deviating region is the same, equation (2) shows that the e-ray will be less absorbed than the o-ray.

The observations taken in this laboratory support the view expressed above. First, the observations were taken for the F-region in the night when absorption in the non-deviating region had become small and the reflection coefficients for the two rays were compared. Since we had no provision for a polarized receiver, the measurements for the reflection coefficients were taken when the splitting had just taken place, so that on high resolving power of the oscillograph, the echoes were distinctly seen. Under these conditions P′ – the group path – was practically the same for the two rays. As a result of these observations it has been found that the e-ray is almost always stronger than the o-ray, which is in accord with equation (2).

Day absorption—We reach the same conclusion from a study of the day-time absorption. It can be easily shown from equation (1) that in an ionized medium the group velocity of the e-ray is less than that for the o-ray, and hence during the day when the F-echo has to pass through both the E and D regions, group retardation splitting can take place so that the e-component will lag in time behind the o-component. This type of splitting will be more pronounced when we approach the critical frequency of the lower region[3]. The observations taken during various afternoons in this laboratory show that at 4 Mc/sec. the F-echo was a simple one (possibly an unresolved doublet), but as the frequency was reduced the echo became a close doublet. The separation between the doublet went on increasing and at the same time the longer delay component—the e-ray—became comparatively weaker and weaker, as the critical frequency of the E-layer in the neighbourhood of 2 megacycles was reached. A typical graph showing the separation of the doublet with frequency is given here. Above λ 122 metres the longer delay component, *i e.*, the extraordinary ray became almost invisible, while the ordinary ray was visible up to λ 150 metres, beyond which the transmitted frequency could not be reduced.

Though the above result seems quite the reverse of the night-time results, it can be easily seen that there is no contradiction, for the day-time absorption is made up of absorption in the deviating region plus that in the non-deviating region. Now although the absorption in the deviating region is less for the e-ray, it is more than counterbalanced by the greater absorption due to longer group path.

As will be seen from the figure that the group retardation becomes very prominent near about the critical penetration frequency of the lower region, it is by no means negligible for frequencies much greater than the critical frequency. Thus it seems most probable that at higher frequencies greatly removed from the critical penetration frequency of the lower region, the 'group retardation splitting' and the 'stratification splitting', which produce opposite effects, balance each other and the stronger o-echo and the weaker e-echo arrive after the same time lag and are consequently unresolved, till on further increasing the frequency the critical frequency of the upper F region is reached and the 'stratification splitting' becomes greater than the 'group retardation spiltting' and the o-ray lags behind the e-ray.



Thus the greater daytime absorption of the F-layer extraordinary echoes definitely seems to be due to more group retardation experienced by the ray, and not due to the generally accepted view that it is due to greater absorption near the reflecting point (Farmer and Ratcliffe)[4].

Experiments are under progress for a detailed quantitative study of the problem.

My thanks are due to Prof. M. N. Saha who was kind enough to favour me with criticism of the view expresse d in this note.

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29.4.1936.

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Obituary

Prof. K. K. Mathur

PROFESSOR Krishna Kumar Mathur's premature death on July 18, 1936, deprived India of an eminent geologist and an educationist. Though of late he had been suffering from a prolonged illness from myloid leukaemia, an incurable disease, the news of his death has come as a sudden shock to everyone who knew him. The educational career of Professor Mathur was all through very brilliant. In all examinations he stood first and secured merit scholarships. After finishing his secondary education he joined the Agra College from where he graduated in the years 1915, topping the list of the successful candidates of the Allahabad University. After he had passed the previous examination in Chemistry, he was awarded the States Scholarship for study abroad. In England he prosecuted his studies at the Imperial College of Science and Technology where he took the B. SC. degree with Honours of the University of London securing again a first class first. Finally he took the A. R. S. M. specializing in geology for which the Government extended the States Scholarship by a year. Uniformly his place was first class first and he was awarded the De La Beche Medal.

Soon after his return to India Prof. Mathur's services were secured by the Benares Hindu University as the University Professor of Geology in the year 1921. He soon distinguished himself as a great teacher and administrator. The Department of Geology owes its growth and development to Prof. Mathur who was its head from the very beginning. His love for the science of geology was great and he was keenly devoted to it. His personality attracted students from all parts of India. At Benares he built up a school of geology, which is all-India in its character. His indomitable spirit in the face of hardship and his great love for the science of geology were a source of great inspiration to his students, who are spread far and wide in India and some of whom hold important offices. His colleagues in the University held him in the highest esteem, and when he was appointed Principal of the College of Science constituted in 1935 every one was indeed very happy at the selection. *Nature* congratulated the University on this happy selection.

In the field of research his principal contributions comprise the petrology of the Deccan Trap igneous activity. He carried on investigations of the study of the various differentiates and threw much light on the genetic processes leading to the formation of the different types. His presidential address to the Geology Section of the Bombay Session of the Indian Science Congress, 1934, on this subject will continue to be a valuable work of reference for long time to come. His research activities also extended to stratigraphy, mineralogy and colloidal chemistry.

Amongst the scientists in India he held a prominent position. He was Vice-President of the Geological, Mining and Metallurgical Society of India for some time. He was a foundation fellow of the Academy of Sciences, U. P., now the National Academy of Sciences of India, the Indian Academy of Sciences, and of the National Institute of Science of India. He presided over the Geology Section of the Indian Science Congress held in Bombay in the year 1934.

In the Benares Hindu University he was a prominent figure in all the administrative and academic bodies. He was a member of the Court, the Council, the Senate and the Syndicate, and had been the Dean of the Faculty of Science for two consecutive terms. He also served on the Faculties of Arts and Ayurved and numerous other boards of studies. He used to take part in all activities and in popularizing scientific studies by taking active interest in publishing scientfic bodies in Hindi.

On the personal side Prof. Mathur was a man of strong principles and high ideals. As an administrator his sense of justice was great, which won for him love from all quarters. He was a strict disciplinarian, though kindly in judging faults. He was simple, sincere, and a great philanthropist. His purse was always open for the poor students and for the cause of science. He carried his greatness with charming modesty, and was a paragon of politeness and gentlemanliness. He was a selfless and conscientious worker. Whatever work, whether great or small, of scientific or of social nature, he took up he used to put his heart and soul into it with the result that he used to overwork himself, a practice which he continued even during his illness. His friends and doctors constantly advised him not to work so hard. But all such advice was vehemently opposed as life to him without work had no meaning. A devoted scholar he hardly enjoyed a vacation. As the nature of his duties demanded his presence at the University all through the working session, he used to lead geological excursions during the hot months of May and June and that too sometimes to places like Rajputana, Cutch, and Kathiawar. Even when at Vienna for treatment he attended International Geological Congress Meetings. This prolonged strain of work with little rest was perhaps responsible for bringing such a brilliant career to a close at the early age of forty-three.

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Irrigation Research in India

THE annual meeting of the Central Board of Irrigation was held at New Delhi during the first week of November. The meeting was opened by H. E. the Viceroy with a speech reviewing irrigation work in India. The Viceroy stressed the importance of irrigation for an agricultural country like India and pointed out that the Government had spent a sum of Rs 150 crores on irrigation so far. He reviewed the activities of the Central Board of Irrigation during the last six years and mentioned the possibility of the establishment of a central research station, where problems of irrigation would be studied with the help of models.

We may remind our readers in this connection that the idea of studying irrigation and other connected problems with the aid of models in a research laboratory before any irrigation scheme is actually sanctioned was first advocated by Prof. M. N. Saha in an article, 'Need for a Hydraulic Research Laboratory in Bengal,' published in the *Sir P. C. Ray Commemoration Volume*, and the idea has since been advocated in a number of articles, published in SCIENCE AND CULTURE, by Dr N. K. Bose and Mr S. C. Majumdar, with particular reference to the problems of Bengal. The Viceroy's speech indicates that the Government has been convinced of the soundness of the ideas advocated in these columns, but we are afraid that though intentions may sometimes be quite good, the method of working out the programme may be unsound, and may wreck the whole scheme. We wish, therefore, to offer the following comments on the problems of irrigation in India.

What is meant by Irrigation

The word "irrigation", used in the broadest sense, is not merely supplying the fields with water, but is really the manipulation of the water resources of a country to its best possible interests. To India the problem of irrigation is of vital importance, as agriculture is here the chief industry and provides food to 80% of her teeming millions. But in extent, India is almost a continent and exhibits an enormous variety of topographical and climatic conditions. On one hand, there are the arid regions of Sind and Rajputana, where soil is sandy and unproductive, rainfall is extremely slight, and vegetation is scarce. Big rivers are mostly absent (except the portion of Sind through which the Indus passes), the only means of water supply being deep wells or rain water stored in artificial lakes at suitable places with the help of dams, as we find scattered all over Rajputana. On the other hand, there are regions like Bengal which is entirely formed of clay brought down by two mighty rivers, the Ganges and the Brahmaputra, and deposited in the course of the last few millenniums. The soil is, therefore, extremely soft, moist, and productive and the country is flat, being absolutely devoid of prominent landscapes like hills or plateaus. The two great rivers flowing over Bengal provide through their main channels and the network of innumerable smaller rivers a more than abundant supply of water to all its parts. The annual rainfall is very high, reaching at places over hundred inches. These circumstances combine to make Bengal liable to floods at frequent intervals. Between the two extreme limits of Rajputana and Bengal, we have the semi-arid regions of the Punjab, and north-west part of the Agra Province. Then again, in the Deccan plateau we are confronted with an altogether different topography. The tableland is crossed by a few rivers. The rainfall varies from being very copious at the coasts to a small amount near the centre of the plateau. The water brought by this scanty rainfall drains out quickly, and leaves the land dry. Besides these three types of regions there are a number of others, like the Konkans, where the main topographical and climatic features differ materially and create a completely different situation, giving rise to a new set of problems.

Problems of Irrigation Different in Different Regions

Even a superficial examination of the above considerations will convince the reader that problems of irrigation differ enormously from province to province and *it is extremely injudicious to apply the methods successful in one province to the irrigation problems of another, a blunder which has very often been committed by engineers in the past in India and caused enormous loss to the country.* The Deccan plateau requires storage of water above everything else, while in the Punjab canals supplying water to riverless tracts have proved to be very successful. Then again, in Bengal, *the problem of supply of water for irrigation does not exist* : what is far more important is to get rid of surplus water as quickly as possible. Owing to a combination of circumstances, *e. g.*, simultaneous rise of two rivers which flow into each other, this does not always happen, and serious havoc is caused by catastrophic floods to the countryside. So we find that the problems being so different from province to province, irrigation experience gained in one province is not likely to be of much help elsewhere.

Irrigation—an ancient Art in India

It should further be borne in mind that irrigation is not a new art imported into India by British rule, but is as old as civilized life in this continent, for the supply and distribution of water are of vital importance to the people. It existed in a highly developed form in many parts of ancient India. It is well known that in the Cauvery valley water was stored by means of an anicut from Hindu times before the Christian era. The Deccan has, from time immemorial, developed huge storage basins by blocking the outlet of mountain streams and thereby creating artificial lakes. The Emperor Firuz Shah cut a canal from the Jumna to water his gardens in the Hissar district in the Punjab, which was renovated, during British times and is known as the Western Jumna Canal. According to Sir William Willcocks, the branches of the Ganges in the Bengal delta were originally a system of canals dug by some ancient king for affording a quick outlet for the Ganges water to the sea. This not only prevented catastrophic floods, but allowed silt-laden water to be distributed over a wide area adding fertility to the soil. Further, it had a healthy flushing action over the whole countryside, clearing all stagnant pools which are the hot beds of malaria and other diseases. According to Willcocks, the decay of these branches is the cause of outbreak of malaria in western and central Bengal. Though irrigation is popularly supposed to be mainly concerned with supplying water to the fields, it must be realized that the planning of bridges and dams across the rivers, and of reservoirs for hydro-electric purposes are also intimately connected problems.

Failures in the Past

The water resources of any country form an organic whole and tampering with it in one section without considering fully its possible effects on the rest of the system may produce serious consequences. The history of irrigation projects in India is full of such dismal stories. Gigantic schemes have been undertaken and pushed by over-enthusiastic and interested persons, and a large number of these undertakings have either fallen short of expectation or have proved disastrous owing to defective planning and gross mismanagement. Among the successful schemes may be mentioned the irrigation canals in the Punjab. But we should not forget that crores of rupees were squandered by Sir Henry Cotton over the Orissa and Midnapore canals, for encouraged by his success in restoring the ancient irrigation system in the Cauvery and the Godavery valleys, he applied the same methods uncritically to entirely different regions like Orissa and western Bengal. Nor are all such failures so old. Glaring blunders are being committed under our very nose and the tax-payer is suffering the loss of crores of rupees. For illustration we take the case of Hardinge Bridge over the Ganges at Sarah. A bridge over the lower Ganges had been under contemplation since 1889 for affording a direct railway communication between the rich jute country in eastern and northern Bengal and Calcutta. A large number of sites were examined for the purpose by the late Sir Francis Spring, who recommended four alternative sites between Teliaghari (the place where the Ganges debouches through the Rajmahal Hills) and Sarah. Of these Sarah, which was the least satisfactory from the engineering point of view and was practically condemned by Spring, was selected owing to the pressure exerted by the all-powerful merchant community represented by the Bengal Chamber of Commerce at Calcutta. Spring complained bitterly of the absence of a river physics laboratory, and found great difficulty in designing, as all necessary data, *e. g.*, discharge of water at maximum and minimum flood, variation of discharge throughout the year, etc., were lacking. In spite of the lack of data and absence of knowledge, the bridge was planned and constructed, not at the first estimated cost of Rs 75 lakhs but at a cost of over Rs 3 crores. According to many competent critics, the excess was due to mismanagement and lack of control over expenditure. But this is not the end of the tale. The river, as if to mock the engineers for their negligence in studying her properly, has repeatedly shown a tendency to leave the present bed, cut a new channel, and leave the expensive bridge in dry land. The Government have been compelled, year after year, to recall their experts from England and spend crores of rupees in trying to protect the bridge. During investigations about three years ago, it was revealed that big boulders deposited at the base of one of its pillars had absolutely disappeared, evidently carried away by the current. This was an eventuality which none of the engineers had thought to be within the range of possibility. Mighty Indian rivers often behave in ways which are not expected by engineers trained in foreign countries and unfamiliar with the conditions in this country. Mr Inglis of the Poona Hydrodynamic Research Institute was commissioned to do model experiments on the Ganges and the bridge at Sarah. He has published a report on the results of his experiments but nothing is known as to what steps have been taken by the Government to test his results on the prototype.

There are other notorious cases where crores of rupees have been wasted on account of faulty planning. We may take the case of the Mundi hydro-electric scheme which was originally estimated to cost two crores, but about ten crores were altogether spent on it before the scheme could be completed. This excessive expenditure was partly due to gross mismanagement, but partly also due to the fact that no satisfactory estimate of the water resources of the Uhl river was available, and still the Government was hasty enough to sanction the scheme, owing to pressure exerted by over-enthusiastic and interested persons. The cost per kilowatt installed has been a little less than three thousand rupees, which is about ten times the amount spent usually on hydro-electric stations, and holds the world's record for high expenses. Probably the history of engineering nowhere in the world reveals such a case of gross mismanagement, faulty planning, and utter disregard of public interests. The Sukkur Barrage cost the huge sum of thirtyfour crores and involved the Bombay Government in large annual deficits, the effect of which is seen in the heavy annual cuts in the grant for education and other nation-building activities in the Bombay Presidency.

Need for Research

Apart from mismanagement and manipulation by the interested parties, a huge amount of public money wasted over these schemes is due to lack of adequate data and other relevant information which must be taken into consideration in the course of planning. In this connection we might refer here to the words of Sir F. Spring, C.I.E., who was Chief Engineer to the Government of India in 1903 and had been deputed by the Government to find out a site for the bridge over the lower Ganges. He realized that, India being a land of mighty rivers, it was extremely important that all necessary information, data, and statistics should be systematically collected and regular research should be undertaken in the science of hydraulics. In his *River Training and Control*, published nearly thirty years ago, he said:

> "It might not unreasonably be expected that the State would see the importance of devoting a comparatively small annual appropriation to original research on lines likely to be productive of a good return for the expenditure, in the form either of the reduction in the first costs of its public works or of their safety and their economical upkeep when built. Heretofore there has been no pretence of organizing any such research in connection with the engineering of canals and railways of India. Engineers have gone on blundering, benefiting rather by chance than by design, by the experience of their predecessors, and each considering himself lucky if he escapes disaster at the hands of the tremendous forces of nature—amongst which some of the most potent for good or evil are the great rivers with which he has to struggle."

Then again :

> "How under so haphazard a system, anything gets done at all is a marvel ; and instead of being surprised at £100,000 worth of work having been wiped out, the State may congratulate itself, if the loss is not double".

That a great deal of public money can be saved by systematic hydraulic research cannot be emphasized too strongly. We may here quote a few words of Mr J. R. Freeman, an eminent American authority on the subject :

> "Last summer at Karlsruhe, I was told that with each practical major problem that had been taken into their river structure laboratory, the saving in the structural cost due to the information thus gained had been more than equal to the entire cost of laboratory building, apparatus and research. At Charlottenburg and elsewhere, I gathered that laboratory research with the help of small-scale models has been equally successful. Personally I have little doubt that suitable river structure laboratory, in skilful hands in the United States, could be made to pay dividends of a thousand per cent per year on its cost."

Research in Foreign Countries

In the progressive countries of the West where rivers play an important part in the life of the people, for the purposes of navigation or agriculture, the study, control, and development of rivers are carried on along scientific lines. Germany has been one of the pioneer countries in this matter as in many other branches of science. Her trained experts and scientists have done immense good to the development of her inland waterways, harbours, canals, and to the dwellers of the riparian tracts. There are permanent Rhine and Danube river commissions composed of experts from different countries through which the rivers pass. Besides these, Germany possesses numerous good hydraulic research laboratories under eminent directors. Austria, Czecho-Slovakia, Hungary, and Sweden also have similar research laboratories. U. S. A. has a number of such institutions, either privately managed or attached to some of her universities. U. S. S. R. has two, one at Leningrad and the other at Tashkend in Central Asia. The Tashkend laboratory is supposed to be the biggest and the best equipped in the world. The work usually done in these laboratories is extremely varied in nature, including problems of sedimentation, erosion, effect of tides on harbour protections, the laws governing the formation of a river course, strength of dams, etc. Though a great deal of work can be done on the general principles of river physics, it is in studying particular problems that such laboratories are most useful. In SCIENCE AND CULTURE, June 1935, Dr N. K. Bose, Research Officer, Irrigation Department, Punjab, described a few foreign laboratories in the course of an article on Bengal Rivers and their Training. While at Charlottenburg (Berlin) he found that experiments were in progress, in which the effects of tides and ocean waves on harbour protection works at the mouth of a river were being investigated in a model under instructions from the Dutch Government. In the course of the investigations a special apparatus had been devised to create artificial tidal conditions in harbour and in the river. It had taken the laboratory more than a year to perfect this. The Dutch Government bought the whole set of apparatus with results obtained till then for 20,000 marks. As far as progress of river physics, as an independent branch of science, is concerned, it is now clearly recognized that observation on natural rivers is a very slow, troublesome, and imperfect method, being not under any sort of experimental control. On the other hand, investigations along purely mathematical lines have also proved barren. Study of river physics as a branch of experimental physics in properly equipped laboratories has proved to be most fruitful.

In India, though the Governments, both Central and Provincial, have executed huge schemes in the past, paying crores of rupees to the foreign capitalist, no organization existed till quite recently where the experience gained by irrigation engineers in different parts of the country could be collated and discussed—not even a library where relevant publications of foreign countries could be easily available. A few years ago the Royal Commission on Agriculture presided over by the present Viceroy recommended the establishment of a comprehensive library of irrigation publications, both Indian and foreign, for the use of irrigation engineers. Eventually in 1930, the Central Board and Bureau of Irrigation were established. The Bureau has a good library and the Board has provided during the last six years of its existence a number of sub-committees to deal with technical problems. It ought to be pointed out that neither the Board nor the Bureau has hydraulic research among its essential duties, though it has been instrumental in bringing out a number of useful publications on irrigation problems.

As a result of persistent public agitation through the press, the Government seem to have realized at last that the research on irrigation problems is necessary. But unfortunately, they have failed to see that a central research station will serve no useful purpose. The Viceroy, in his speech, opening the Central Board of Irrigation, said:

> "I notice that one of the questions to be discussed at your meeting is that of the establishment of a central research station for irrigation. The Royal Commission on Agriculture concluded in the light of their investigations that such an institution was not desirable and that provincial research was of greater importance. But since the date of our report much has happened and much further experience has been gained. I understand that during the past ten years as a result largely of the use now made of models in solving irrigation and river-control problems there is now a strong demand for research of an all-India nature. I attach great importance to this work which, if successful, should make a most material contribution towards the solution of a set of problems important in many areas and in some of pressing urgency and significance."

We are afraid that the Viceroy has been rather enthusiastic in his advocacy of a central research station for irrigation. From what we have said earlier it will be clear that a central research station for hydraulics cannot serve the interests of the whole of India, as the problems in different regions are entirely different. There are at present four research laboratories, one at Poona, which is being subsidized by the Government of India for 1937-38, the second at Lahore, entirely run by the Punjab Government, the third one at Sind, financed by the Sind Government, and the fourth a small one, only recently started in U. P. They are doing good work for their respective provinces and may be further developed, and we are entirely opposed to their abolition or absorption by a central research station. A hydraulic research station is very badly needed for the lower Ganges valley (Bihar and Bengal), but it will be a blunder to suppose that problems of these regions can be solved by a station situated at Delhi, for the Delhi officials cannot have the opportunity to study the problems firsthand, unless they are constantly touring in Bengal.

Final Suggestions

Our final suggestions are that separate hydraulic research laboratories and departments of field service run by the provincial governments and subsidized, if necessary, by the Central Government, should be organized for well-defined regions separately and that problems should be studied scientifically in each laboratory and data collected before any irrigation problem, used in the widest sense implied in this essay, is actually tackled.

Besides the four existing laboratories which should be developed, at least two more hydraulic laboratories should be opened, one for Bihar, Bengal, and Orissa, and another for Madras and the lower Deccan. The one for the lower Ganges may be stationed at Calcutta subsidized by the three provincial governments, the Central Government, the Corporation of Calcutta, and the trustees of the Calcutta port. It must be pointed out that the last two parties have vital interest in keeping the deltaic rivers of the Gangetic valley open.

There is a purely scientific side which must not be forgotten. We do not as yet know much of the physics of river flow. Research in this direction may be encouraged by giving grants to professors in universities and engineering colleges. No useful purpose will be served by a co-ordinating central body. But workers from different laboratories may occasionally meet and interchange views as is done by the research workers of the Agricultural Research Council.

The laboratories should be planned on the model of the latest river physics laboratories in Europe and should be placed under the control of those who are familiar with the latest methods of research in river physics. The usual practice in this country is to place such research institutions under the control of engineers in Government service, who have no previous knowledge of hydraulic research. Such a system defeats the purpose of the organization, for by the time the engineer learns anything of actual science he will probably be on the retired list or be transferred elsewhere. For field service, young men should be trained in research laboratories and sent out on definite programme. No engineering scheme should be undertaken or sanctioned unless all hydraulic data have been collected and the plans have been tested by competent experts in research laboratories.

Such laboratories should study problems of river training, flood irrigation (when necessary), navigation and water power development.

The duties of the department for field service will be to undertake a hydrographic survey of the province including collection of accurate information regarding supply and distribution of water in the river system of that region. It should also make a contour survey of the region, collect all data regarding rainfall and subsoil water and other geophysical factors likely to be of use in the preparation of great, constructive plans.

Chinese Culture before and after Indianization

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Laws of Cultural Borrowing

THE long history of Indianization of Chinese institutions, thought, art and life in general, furnishes the most extensive material that can be found for the study of cultural *borrowing* on the grandest scale. Indeed, nowhere in the world, with the only possible exception of the Christianization of Europe, can one find another source of historical materials equal in extent and in length of time. I venture to say that this attempt to study the Indianization of China as a case of extensive cultural borrowing may be found at least of suggestive value to the study of the parallel, though not quite similar, story of the Christianization of Europe.

Commonsense tells us that borrowing means A taking from B something which B has and which A has not. In the case of cultural borrowing the relationship of "have" and "have-not" is not so simple, but is often relative and graded. There are at least several broad grades.

1. A has C
   B has not C and wants it.
2. A has D
   B has D_1
   And the superiority of D to D_1 can easily and clearly be demonstrated.
3. A has E_1
   B has E_2
   But it cannot be easily shown that E_1 is superior to E_2.
   It may turn out that E_2 is even better.
4. A has F
   B has G
   But G is directly opposed to F.
5. A has H, I, J, K, etc.
   B has not these and is not in need of them.

Cultural borrowing readily and voluntarily takes place in the first case. In the second type, borrowing is made usually when the superiority of the imported culture is clearly demonstrated. In the other types, cultural borrowing becomes impossible sometimes because of native indifference, sometimes because of strong oppositions, and sometimes because of mere sentimental attachment to traditional culture.

The mechanical time-clock which the early Jesuits and European traders brought to China 300 years ago soon replaced the clumsy water-clocks of the indigenous civilization. The Jesuits also brought to China the new methods of astronomical calculation and calendar reform. These were at first vehemently resisted by the native astronomers. But, after forty years of struggle and fifteen years of rigid competition in astronomical calculation and prediction, the superiority of European science was so clearly demonstrated that the new calendar worked out by the Jesuit scientists was officially adopted by the government and remained in force until very recent years.

But an alien culture rarely comes in single and isolated items. It always involves a vast complex of varied elements, of which some may be strongly opposed to their counterparts in the native civilization, while others are often resisted by indigenous counterparts which the native people consider good enough for their forefathers and therefore good enough for themselves. And, after all, who shall be the judge of which is the "better" in such indefinable matters as human relations, moral values, intellectual standards, or religious ideas and practices ? In all these spheres, emotional attachment is usually strong and objective evaluation difficult. Moreover, it is impossible to demonstrate satisfactorily that, of these more or less similar or more or less opposing counterparts, one form is really "better" than the other. The early Jesuits in China, for example, who could demonstrate conclusively that their predictions of eclipses of the sun and the moon were by far more exact than those of the native astronomers, found themselves in great difficulty to prove to the Chinese that ancestral worship was idolatry, that polygamy was wrong, that the Holy Virgin was more powerful than the Goddess of Mercy, that the Christian God was more real and more lovable than the Chinese Tien or that the Confucianist doctrine of the goodness of human nature was inferior to the Christian idea of original sin.

But there are times when these natural barriers are not sufficient to prevent a people from wholesale and indiscriminate acceptance of an alien culture. Such times occur during periods of fanatic religious fervour, and during periods of fanatic waves of nation-wide zeal for radical reforms. Japan in the last three decades of the nineteenth century was a case of wholesale cultural borrowing during a period of almost fanatic zeal for political reform. China, in 1898, and again in 1926, came nearest to this fanatic level.

But great waves of religious fanaticism have been the usual historical occasions of large-scale cultural borrowing. During such periods of powerful mass conversions to a new religion, people easily lost their sense of calm evaluation and embraced everything that might accompany the new faith. Sometimes it requires a long period of slow penetration ; sometimes it requires great leaders of magnetic force to sway the masses. But, when it becomes a mass movement of vast numbers, the momentum is so great that kings and queens, emperors and empresses, princes and princesses, the noble and the lowly, are swept along with it, and the new faith, together with all its vast paraphernalia, good or bad, useful or useless, desirable or undesirable, digestible or indigestible, is accepted *in toto* with eagerness and enthusiasm.

And when the first enthusiasm and bewilderment are over, when critical judgment returns with the lapse of time and with more intimate knowledge, the new faith, together with all its appendages, has already been well enthroned and entrenched in the country. Then there began the period of doubt, of criticism, of open revolt, and even of drastic persecution. To be sure, there may have been earlier periods of doubt and opposition. There were Neroes long before Constantines. But persecutions during great waves of religious enthusiasm only rendered to the persecuted faith the services of free publicity and conferred upon it the additional attraction of heroic martyrdom.

With the return of calm judgment and, what is more important, with the natural re-assertion of the inertia and resistance of the native culture, the borrowed culture necessarily undergoes all forms of changes, modifications, adaptations, domestications, and eliminations. In case of minor religions which had only comparatively small following and had not had sufficient time to take root in the new soil, sustained persecution might succeed in completely suppressing them. Such was the case with Zoroastrianism, Nestorian Christianity, and, to a lesser degree, Manichaeanism in China.

But Buddhism could not so easily be uprooted by persecution. For two thousand years, it continued to be one of the greatest, indeed the greatest, religions in China, continuing to Indianize Chinese life, thought, and institutions. It constituted the only important source of China's cultural borrowing prior to her contact with the European civilization. It continued to flourish in China, and through China, in Korea and Japan, even long after it had disappeared in its mother country, India. It continued to Indianize China long after it had ceased to be a vital and powerful religion in China. Indeed, as we now begin to understand, Indianization became more powerful and effective throughout those centuries when Chinese thinkers began to rejoice that they had killed Buddhism or at least made it innocuous. Buddhism is dead in China—long live Buddhism !

It is my purpose to trace this long process of Indianization through its various successive stages. Broadly speaking, these stages are :—

1. Mass Borrowing ;
2. Resistance and Persecution ;
3. Domestication ;

and 4. Appropriation.

By mass borrowing I mean not only the simple process of China taking from India all those things which were either totally absent or weak in the indigenous civilization; but also that mass movement of religious enthusiasm which blindly embraces everything that accompanies the new faith. By resistance and persecution I mean to include those periods of history when China began to doubt and question the invading culture which was then openly opposed by Chinese thinkers and persecuted by governmental action. By domestication I mean to include all those tendencies consciously or unconsciously to make the Indian religion, art, thought and institutions take up more and more Chinese colours, to make it more "at home" in China in order that the Chinese people might feel more at home in them. By appropriation I mean the culminating stage of successful borrowing when the essence, if not the bodily totality, of the borrowed culture is unconsciously "appropriated", recognized by the native population as their own.

Triumph of Buddhism

In order to appreciate the vast scope of Chinese borrowings from India, it is necessary first to understand the truly striking contrast between the ancient cultures of those two peoples, especially in their religious beliefs and practices. The ancient Chinese people, who built up their civilization in the north-temperate zone where the struggle against the forces of nature was severe, had worked out only a very simple and plain religion, consisting of the worship of ancestors, of the natural forces and of a supreme God or Heaven; the belief in divination; and a vague conception of retribution of good and evil. There was neither Heaven in the sense of a Paradise nor Hell in the sense of the place of Last Day Judgment. There were practically no mythologies, nor elaborate rituals. It was the religion of a hard-working and plain-thinking people.

But, as the race became more mature and more sophisticated, it began to yearn for something more satisfying or at least more tantalizing than the too simple religion of its ancient fathers. Throughout the third and second centuries B.C., there were numerous ambitious quests for strange innovations in religious belief and practice, grandiose imperial quests for the great unknown mystery which the too pragmatic and rational mentality of indigenous China could not possibly satisfy.

Then there came the great religion of the Buddha together with all the Mahayana trimmings of the pre-Buddhist and non-Buddhist religions of India. Never before had China seen a religion so rich in imagery, so beautiful and captivating in ritualism, and so bold in cosmological and metaphysical speculations. Like a poor beggar suddenly halting before a magnificent storehouse of precious stones of dazzling brilliancy and splendour, China was overwhelmed, baffled, and overjoyed. She begged and borrowed freely from this munificent giver. The first borrowings were chiefly from the religious life of India, in which China's indebtedness to India can never be fully told. India gave China, for example, not only one Paradise, but tens of Paradises, not only one Hell, but many Hells, each varying in severity and horror from the other. The old simple idea of retribution of good and evil was replaced by the idea of transmigration of the soul and the iron laws of Karma which runs through all past, present, and future existences.

These and thousands of other items of belief and practice have poured from India by land and by sea into China, and have been accepted and gradually made into parts of the cultural life of China. The ideas of the world as unreal, of life as painful and empty, of sex as unclean, of the family as an impediment to spiritual attainment, of celibacy and mendicancy as necessary to the Buddhist order, of alms-giving as a supreme form of merit, of love extended to all sentient beings, of vegetarianism,* of rigid forms of asceticism, of words and spells as having miraculous power—these are only a few drops in that vast flux of Indian religious and cultural invasion.

The general aspects of the story of the spread of Buddhism in China are comparatively well known. Suffice to say that, according to our present knowledge, Buddhism had probably come to China long before the year 68 A.D. commonly assigned as the date of its introduction; that probably it had come to China, not as religion officially introduced by an emperor, but only as a form of popular worship and belief among the people—probably among the poorest and the most lowly, to whom the Buddhist missionaries, traders, and travellers had brought the good tidings of mercy and delivery from pain. In all probability, it was from the populace that the prince Liu Ying (died 70), younger brother of the emperor, caught the contagion and was converted to Buddhism. It was also from the popular worship that the Emperor Huan-ti (147-167) elevated the Buddha and made him an object of worship in his palace. The apparently rapid progress made by Buddhism in the Yangtse Valley and on the southern coast towards the end of the second century seems to indicate that it had had a long period of slow but steady permeation among the people. By the third century when the men of letters began to admire and defend it, Buddhism had already become a powerful religion, not because of governmental patronage, of which there was very little, but because of its powerful following among the people.

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* Vegetarianism was not so much insisted upon by Buddhists as by Jains—Editor.

It was as a popular religion of the poor and the lowly that Buddhism first came to stay in China. As such, Mahayana Buddhism came *in toto*, and was accepted by the Chinese believers almost *in toto*. It was not for the masses to choose and reject. A great religion of powerful popular appeal came and was accepted. That was all.

Indeed, in their religious enthusiasm, the Chinese people soon came to look to India as "the Land of the Buddha", and even as "the Western Heaven" from which nothing but the great truths could come. Everything that came from the "Western Heaven" must have a reason and commanded acceptance. Buddhism, or that whole movement of cultural invasion which went by the name of Buddhism, was bodily taken over by China on the high waves of religious fervour and fanaticism.

Reaction against Buddhism

But the Indianization of a country with an established civilization like China could not long be smooth sailing. Gradually grave doubts began to crop up. Chinese thinkers began to realize that this Indian or Buddhist culture was in many fundamental aspects directly opposed to the best tradition of China. They began to resent the conquest of their ancient civilization by a "barbarian country".

Of the truly fundamental differences, a few may be mentioned here:

First, the Buddhist negation of life was contrary to Chinese, especially to Confucianist, ideas. To the Confucianist, the individual life is a sacred inheritance and it is the duty of the individual to make the best of that life—at least not to degrade it or destroy it. One of the most popular texts of Confucianism, *The Book of Filial Piety*, says: "The human body, even every hair and every skin of it, is inherited from the parents, and must not be annihilated or degraded". Ancient Chinese thinkers of the fourth century B. C. taught that life is of the highest value. The Buddhist doctrines that life is an illusion and that to live is pain led to practices which the Chinese could not but regard as revolting and inhuman. Throughout the history of Buddhist China, it was common practice for a monk to burn his thumb, his fingers, or even his whole body as a form of merit in emulation of the supreme sacrifice of the Bodhisattva Bhaishajyaraja, the King of Medicine, one of the deities of Mahayana Buddhism. Both the two great *Buddhist Biographical Series* devoted one section to biographies of Chinese monks who had burned themselves to death, or otherwise committed suicide, as supreme sacrifices. This section is under the heading, "Those who gave up their Lives". It contains detailed stories of hundreds of such suicides. A monk would announce his date of self-destruction and, on that day, he would tie his whole body in oiled cloth, light the fagot pier and his own body with a torch in his own hand, and go on mumbling the sacred titles of the Buddhas until he was completely overpowered by the flames. Very often such human sacrifices were witnessed by thousands of pious Buddhists whose plaintive wailings would accompany the slow burning of the pious monk. China seems to have completely gone mad in one of her strange periods of religious fanaticism.

Secondly, the Buddhist monk and nun must renounce all their family relations and must practise celibacy. This was also contrary to Chinese traditions. The whole Confucianist ethics had been one of relationships, of which the family ties, being the most intimate, were regarded as the most important. Indeed, Mencius once said that, of all acts against filial piety, the failure to have children was the worst. Celibacy was directly opposed to this traditional emphasis on posterity. The seriousness of this practice became all the more apparent when the number of monks and nuns grew to millions.

Thirdly, the mendicancy of the whole Buddhist order was condemned by Chinese moral and economic thinkers as "parasitic" and as responsible for the poverty and disorder in the country. All the orthodox economic thought of pre-Buddhist China had taught that labour alone was essential to production and that the merchant class was to be discouraged because they were parasites who "were fed without cultivating the fields, and were clothed without their women working in sericulture." And now came the vast host of monks and nuns who not only would not work, but often accumulated immense wealth for their monastic orders through the extravagant alms-giving of the lay patrons. The economic consequences became quite alarming in those times when almost every eighth person in the Empire was a monk, a nun, or a dependant of a monastery!

Fourthly, the whole outlook of Buddhism on life was "other-worldly", pointing to an escape from this world and this life. That too was quite opposed to the moral teachings of classical China. The Buddhist practised all forms of mental control and meditation, and accumulated "merit" by all forms of *Sutra*-reading and spell-reciting, but—for what purpose? The only answer was: for the salvation of the practitioner, which, of course, was a petty and selfish motive in the eyes of the Chinese thinker. As a Chinese critic of the twelfth century put it, "What we should attend to is precisely that span of life from birth to death. Buddhism completely ignores this life and devotes itself to speculating about what goes before birth and after death. And the earth, the mountains and rivers, which the Buddhists consider as empty and unreal, nevertheless stand out as concrete realities that cannot be conjured away by magic or philosophy."

Fifthly, the whole Indian imaginative power, which knows neither limitation nor discipline, was indeed too much for the Chinese mind. Indigenous China was always factual and rarely bold in imagination. "Extend your knowledge, but leave out those things about which you are in doubt." "Say you know when you really know, and say you don't know when you really don't know—that is knowledge." Such were the wise instructions of Confucius on knowledge. This emphasis on veracity and certainty was one of the most marked traits of ancient Chinese literature, which is strikingly free from mythological and supernatural elements. Confucius once said: "I have devoted whole days without food and whole nights without sleep, to thinking. But it was of no use. It is better to learn than to think in abstract". This self-analysis on the part of one of China's greatest sages is of peculiar significance in showing the suspicion with which Chinese thinkers regarded the unbridled exercise of thought and imagination. It must have been very difficult for Chinese readers to swallow down all that huge amount of sacred literature of sheer fancy and imagination. It was probably this native detestation of the unbridled imagination which led the first Chinese leaders of anti-Buddhist persecution in the fifth century to declare that the entire Buddhist tradition was a myth and a lie.

These and many other fundamental differences between indigenous China and the Indianized China were largely responsible for the numerous religious controversies and the four major anti-Buddhist persecutions of 446, 574, 845, and 955. It is significant to note that all edicts for the persecution of Buddhism emphasized the fact that Buddhism was an alien religion introduced from a foreign barbarian country, and that it was a national disaster and humiliation for the Middle Kingdom to be thus "barbarized". Han Yü (768-824), probably the intellectual father of the great persecution of 845, coined these concise slogans: "Restore their people to humanity! Burn their books! And return their buildings to human residences." The first slogan literally reads: "Man their men", meaning that all those who embraced this alien religion were not to be considered as "men"! Thus in the edict of persecution of 845, after enumerating the temples and monasteries demolished, the millions of acres of monastic land confiscated and the vast numbers of monks and nuns forced to return to lay life, the Emperor said: "Henceforth all affairs of monks and nuns shall be dealt with by the Bureau of Foreign Affairs". That is to say, all who are converted by a foreign religion were no longer considered as Chinese subjects.

These were expressions of a nationalistic consciousness behind which was the only partially articulate recognition that this great religion introduced from the "Western Heaven" contained many ideas and practices which had undermined the moral, social and economic traditions of the Chinese nation.

Gradual Assimilation of Buddhist Culture

But none of these nation-wide persecutions ever lasted more than a few years and none succeeded in eradicating or even diminishing the tremendous influence of the Indian religion in the country. When a persecuting emperor died, his successor invariably adopted a more lenient policy and, in the course of the years, the once-persecuted religion flourished again in all its former splendour and grandeur.

It is a significant historical fact, however, that while no more governmental persecution of Buddhism was undertaken after the 10th century, the religion of Buddhism gradually weakened, withered, dwindled in its power and influence and finally died a slow but natural death. Why? Where drastic persecution had failed, the more subtle processes of domestication and appropriation were meeting with greater and greater successes. Buddhism in its domesticated form was gradually and unconsciously "appropriated" by the Chinese people.

Domestication is a common phenomenon in all cultural borrowings. A folk-song, or a folk-story, introduced from a distant province, is soon revised by nobody knows whom, and, while the main theme—the motif—is always retained, most of the details (names, scenery, fashion, dress, footwear, hair dress, etc.) have been retouched with "local colour". And, after a period of successive domestications, it becomes quite difficult to recognize its distant or even alien origin.

Almost every phase or element of Buddhism has undergone some degree of domestication during these twenty odd centuries. Look at the faces of the deities in a Buddhist temple in China today and trace each to its earliest Indian originals, and you will realize how the process of domestication has worked. The most striking examples are the various stages of transformation of the god Avolokita who has long been "unsexed" and become the goddess of mercy, often represented as a beautiful woman with tiny bound feet. Maitreya has now become the big-bellied, good-natured, heartily laughing Chinese monk that greets you as you enter any Buddhist monastery in China. Indeed, all faces of the Buddhist deities have been Sinicized through a long but unconscious process of domestication. Even in those cases, as in the case of the 16 or 500 *arhats*, where the sculptor or moulder consciously tries to create "foreign" types, the resultant creations are invariably more Chinese than Indian.

Music, painting, architecture, and the other fine arts which came from India together with the Buddhist religion, were also subject to processes of domestication. The reciting and sing-songing of Sanskrit texts have become entirely Sinicized; and Indian melodies have been made vehicles of Chinese songs in which their Indian origins are often forgotten. In painting, as in sculpture, the domestication went so far that later Buddhist paintings are essentially Chinese and differ radically from the early Buddhist art and also from the later artistic development in India herself.

Domestication of Buddhist Philosophy

The most difficult phase of domestication, naturally, lay in the sphere of the religious, moral, and philosophical teachings of Buddhism. Being in most cases basically opposed to ancient Chinese tradition and contrary to the intellectual habits of the Chinese people, these teachings could not be easily digested. Sufficiently abstruse in themselves, they became unintelligible in the translations, of which, as we know, very few were made by really competent scholars well versed in the languages and in the subject-matter.

The most natural step in early attempts to understand this alien religion was to interpret it in terms of concepts which came nearest to the foreign ideas and which were most familiar to the native mind. Buddhism came to China at a time when the philosophical ideas of Lao-tze and Chuang-tze were being revived and having a general vogue among the intellectuals who had grown tired of the Neo-Confucianists of the Han Dynasty. The philosophical naturalism and nihilism of this Taoist school had certain affinities with a number of ideas of philosophical Buddhism, and it soon became a fashion to translate Buddhist terminology into words bodily taken from the sayings of these Taoist thinkers. Such borrowed terms are never exact; *nirvana*, for example, was not *wu-wei* and an *arhat* was not a *shien jen*. But that was the best that could be done in the early stages of intellectual and philosophical borrowings. These Taoistic interpretations furnished the bridge of cultural transmission and made the new ideas of India more easily acceptable to the Chinese intelligentsia. It was the first stage of domestication.

As the work of translation proceeded in later centuries, the Buddhists insisted on the importance of not using existing philosophical terms of the ancient Chinese thought. They preferred the method of exact transcription of the original sound, as *bodhi* (wisdom), *prajna-paramita* (the path of attainment through philosophic understanding), *nirvana*, *yoga*, *dhyana*, *samadhi*, and so forth. But whatever be the terms used, the Chinese reader continued to "interpret" and understand them in the light of what had been most familiar and intelligible to them. And it was the naturalistic and nihilistic background of ancient Taoistic philosophy that made it possible for the philosophical thought of such Mahayana schools as the *Madhyamaka* to be understood by the Chinese intellectuals.

Wherever such a favourable background is lacking, understanding and acceptance became well-nigh impossible despite great native leadership and imperial patronage. Hsüan Chuang (596-664), the great Chinese pilgrim, who went to India at the height of Vijnanavadin thought, and, after spending 15 years studying it, brought back a vast amount of Vijnanavadin literature to which he devoted the remainder of his life to translate into Chinese. This school had developed a most abstruse system of what may be termed introspective psychology which analyses consciousness into over 500 states of mind and their corresponding faculties and objects. Such hair-splitting differentiations simply could not be done in the Chinese language. In spite of the great personal leadership of Hsüan Chuang and some of his immediate disciples, the vast amount of Vijnanavadin literature remained a sealed book and produced practically no influence in the intellectual life of China. The study of the psychological and logical treatises of this school was revived during the recent decades in Japan and later in China because the introduction of modern European psychology and logic had furnished new materials and a new set of terms for comparison and for interpretation. This is another illustration of the fact that borrowings in the field of speculative thought can only be done under such favourable conditions as to make it possible to interpret the unfamiliar in terms of the familiar.

The failure of the Vijnanavada system in China also shows the negative phase of cultural domestication. What we cannot digest we discard. Discarding means the elimination of all those elements which the native culture cannot assimilate or which the native population regards as non-essential. The never-ending importation of new *Sutras* and treatises from Buddhist India throughout many centuries began to trouble the Chinese intellectuals. As early as the 4th century, Chinese Buddhists began to ask the question: What after all is the essence of this great system of the Buddha? Gradually they formulated their answer: The essence of Buddhism is Meditation and Insight. All else can be discarded. Gradually it was recognized that these two phases might be conveniently combined in the one term *yoga* or *dhyana*, which means meditation but which also implies and relies on philosophical insight. From 400 on, there was a clear tendency among Chinese Buddhists to grasp the idea and practice of *dhyana* or *yoga* as the essence and consummation of Buddhism.

Simultaneously, there arose the movement to give special prominence to the *Amitabha* or Pure Land Sect. This sect laid special stress on Faith. Faith in the existence of the Pure Land presided over by the Amita Buddha of infinite longevity and enlightenment; and constantly reminding one's self of this faith by daily repeating the formula "Namu Amitava"—this is alone sufficient to insure final attainment and salvation. This form of Buddhism, because of its extreme simplicity, has had the greatest appeal to all classes, and has survived all other more sophisticated sects.

All these tendencies were towards simplification or filtration. But a more radical voice arose in the 5th century in the person of the learned monk Tao Sheng who taught the revolutionary idea of "Sudden Enlightenment" as against all forms of "gradual attainment". He had been trained in the nihilistic philosophy of Lao-tze and Chuang-tze, and paraphrasing the latter, he declared: "The word is the symbol for the idea; and when the idea is grasped, the symbol may be discarded." In these words we hear the first declaration of Chinese Zennism revolting against the terrible burden of the hair-splitting verbalism and pedantry of Indian scholasticism. And "Sudden Enlightenment" was to be the weapon of this revolt. Grasp the idea and throw away the wordy symbols!

For even *dhyana* or *yoga* includes a tediously long series of arduous and minute practices of gradual attainment, beginning with the simple form of breath-control, passing through all intermediate stages of rigid mental and emotional control, finally ending in the attainment of perfect tranquillity and ease together with the acquisition of magical powers. Even this was too scholastic for the Chinese mentality.

From the 7th century on, there arose the Southern Schools of Chinese Zennism which was built on the central idea of Sudden Enlightenment and which discarded all the scholastic verbalism, the slavish ritualism, and even the minute practices of meditation. "Buddha-hood is within you. Worship not the Buddha, for the Buddha means the Enlightened One, and Enlightenment is within you. Abide not by the Law, for the Law simply means Righteousness, and Righteousness is within you. And abide not by the *Sangha* (the Brotherhood of monks), for the brotherhood simply means purity in life, and purity is within you." Thus spoke Hui-neng, the founder of Southern Zennism.

By the 8th and 9th centuries, the Zennists were becoming truly iconoclastic. They frankly said: "There is neither Buddha-hood to attain, nor the Truth to obtain." "Wherefore do ye busy yourselves without cease? Go home and take a rest. Try to be an *ordinary man*, who eats, drinks, sleeps, and moves his bowels. What more do you seek?"

And they developed a pedagogic technique of their own, the essence of which consisted of urging the novice to seek his own awakening or enlightenment through his own thinking and living. No other salvation was possible.

The whole Zen movement from 700 to 1100 was a revolt against Buddhist verbalism and scholasticism, but it was also a movement to Sinicize Buddhism by sweeping away all its scholastic verbiage and giving special prominence to the idea of salvation through one's own intellectual liberation and insight.

True, this process of discarding and expurgation left very little of Buddhism in the net outcome. But we must admit as a historical truth that 400 years of Zennist expurgation had really domesticated the Buddhist religion and made it intelligible and attractive to the Chinese mentality. By the 11th century, Zennist Buddhism was more a philosophy than a religion. But that was exactly what it should be. For was not original Buddhism more a philosophy than a religion? Unconsciously and unwittingly the Chinese Buddhists, throughout a long period of a thousand years, had succeeded in shearing Mahayana Buddhism of all its extraneous verbiage and in remaking it into a philosophy, a method, and a technique. Unconsciously, they had made their Buddhism nearer to primitive Buddhism than any Hinayana or Mahayana sects had ever been. And incidentally, they had thereby so domesticated Buddhism as to make it easily understood and appreciated by the Chinese intelligentsia.

By the 11th century, this process of domestication was complete and it remained for the Chinese intelligentsia to appropriate this domesticated Buddhism as an integral part of Chinese cultural life.

No cultural borrowing is permanent until the borrowed culture is "appropriated" by the native people as their own and its alien origin is completely forgotten. In the case of Buddhism, all these elements which have not been so appropriated by the Chinese people remain to this day as the unassimilated elements of a foreign culture. The work of Indianization of Chinese thought and institutions has come about through those phases of Buddhism and Indian culture in general which have been so thoroughly domesticated and assimilated as to be unconsciously regarded by the Chinese people as their own.

Chinese borrowings from the culture of India were made in two main instalments. The first portion of the borrowings came as a result of the period of mass conversion to Buddhism. The religion of Mahayana Buddhism which contains numerous elements of the pre-Buddhist Hindu religions, became firmly established as a great popular religion in China. Many of the cultural elements that came with the Buddhist faith, as I have pointed out, were things which the traditional culture of ancient China never possessed. They filled what may be called a "cultural (at least religious) vacuum" and were eagerly accepted by the believing masses. It was this portion of the borrowed culture that was the first to be appropriated by the Chinese.

The second portion consisted of more subtle elements of the Indian culture—the philosophy of the world and of life, the moral and social standards, the intellectual habits—things to which the believing masses were indifferent, and which had much resistance to encounter from the age-long cultural make-up of the Chinese people. It was these elements which had required much intermediate work of sifting, discarding, distilling, and re-interpreting, before some of them were sufficiently domesticated to be unconsciously appropriated into the Chinese culture.

Historically, the first period of Appropriation coincided with the rise of the religion of Taoism, and the second Appropriation coincided with the revival of the secular Confucianist philosophy.

Taoism—an Imitation of Buddhism

Taoism as a popular religion (as distinct from Taoism as a philosophy) rose in the centuries following the gradual spread of Buddhism in China. "Tao" means a "way". There were many "ways" towards the end of the second century A.D. After the third century, one form of Taoism, with its charity organizations, its practices of healing by praying, and of confession of sins, and with its polytheistic worships, gradually acquired a large following not only among the people, but also among the upper classes. Beginning as a consolidated form of the earlier "Sinitic" religion of the Chinese people, Taoism received a great impetus from its impact with the imported religious system of Buddhism. There seemed to be a strong desire on the part of the Taoists to supersede and kill this foreign rival by imitating every feature of it. They accepted the Heavens and Hells from the Indian religion, gave them Chinese names and assigned to them Chinese gods to preside over them. A Taoist canon was consciously forged after the model of the Buddhist *Sutras*. Buddhist rituals were freely adopted into the Taoist worship. Orders of priests and priestesses were established after the fashion of the Buddhist order of monks and nuns. The Taoists had also a form of meditation which was undoubtedly a modification of the Yoga practice of India. The ideas of Karma and transmigration of the soul throughout the existences were also appropriated by the Taoists, and made the central idea in their conception of retribution of good and evil. The idea of transmigration was only modified by the Taoist belief that the individual could attain personal and physical immortality, and thereby escape transmigration, by contemplation, medical aid, and accumulation of merit.

Since the fifth century, there were many attempts of the Taoists to oust Buddhism as an alien religion and to establish Taoism as its sole native substitute. Taoist influence was behind practically all the governmental persecutions of Buddhism.

While Taoism was intended to be a rival and substitute of Buddhism, it was too much an imitation —indeed a crude imitation—of that foreign religion to differentiate itself from it and to command real respect and adherence from the intellectual class. Moreover, its whole outlook on life was just as other-worldly as the Buddhist's. The Taoist ideal was also to flee from this life and this world and seek individual salvation. It was as selfish and anti-social as the Buddhist. It was for this reason that in all the Confucianist attacks on the medieval religions, Taoism and Buddhism were always mentioned together as the joint object of attack. By too much appropriation of an alien religion, Taoism had alienated the sympathy of the more nationalistic critics in the country.

Revival of Confucianism—Secularization of Buddhism

The revival of the secular Confucianist philosophy in the eleventh and twelfth centuries was professedly anti-Buddhistic. Its object was to revive and re-interpret the moral and political philosophy of the school of Confucius and Mencius as a substitute for the individualistic, anti-social, and other-worldly philosophies of the Buddhist and Zennist schools which had prevailed throughout the medieval period. The object was to revive a purely secular Chinese philosophy to take the place of the religious and non-Chinese thought of the previous age.

A statesman of the eleventh century had pointed out that, during the whole Buddhist period of about a thousand years, the best minds of the nation flocked to Buddhist schools of thought and belief merely because the Confucianist teachings were too simple and insipid to attract them. The problem in the revival of Confucianist thought, therefore, was how to re-interpret the Confucianist classics so as to make them sufficiently interesting and attractive to the best minds of the nation.

As if by a miracle, the Confucianist philosophers of the eleventh century suddenly discovered that the old classical writings of Confucius and his school could be made as interesting and attractive as the Buddhist and Zennist teachings! They discovered, to their great delight, that all the philosophical problems of the universe, of life, of the mind, of knowledge, and of religious reverence, which had engaged the speculative philosophers of Buddhism for centuries, were to be found in the ancient classical writings and only required a little re-interpretation to bring forth the hidden meanings of those long neglected works of the ancient sages. So they set themselves to work at this re-interpretation.

These philosophers succeeded in working out a "rational philosophy of Neo-Confucianism" which had a cosmology, a theory or theories of the nature and method of knowledge, and a moral and political philosophy. This new secular philosophy also laid great stress on the perfection of the individual which was to be achieved through extension of knowledge, purification of the will, and rectification of the mind. The extension of knowledge was to be achieved by going to the things and investigating into the reasons thereof. And the rectification of the mind and purification of the will depended upon the cultivation of the attitude of reverence.

But, these Confucianists proudly pointed out, the perfection of the individual was not the end in itself, as was with the medieval religions. The perfection of the individual was only a step leading to the social ends of successfully ordering the affairs of the family, the state, and the world. All intellectual and moral training leads to the rectification of the individual life from which shall radiate all his social and political activities. It was this social end which differentiated the secular Confucianism from the other-worldly religious system of old.

And all this new philosophy was found in the old neglected writings of classical Confucianism. The new *interpretation seemed so natural, so* reasonable, and so satisfactory that it was really inconceivable that such precious teachings should have been allowed to lie unnoticed for all those centuries!

The historical fact was that all this re-interpretation had been the result and product of one thousand years of Buddhistic philosophizing and training. Especially the four hundred years of Zennist Buddhism had given the Chinese mind a new set of intellectual habits, and a new source of reference material. It was as if the naked eye had been aided by a new eye-glass which enabled him to see things which he had been unable to see before. And the eye-glass was, unfortunately, coloured. He now saw things through this eye-glass coloured by centuries of Buddhist and Zennist training. He now re-interpreted all he saw in that new light. He was unconsciously appropriating what he had honestly disowned and revolted against.

The Rationalist philosophers did make a great success of their Confucianist revival and of their re-interpretation of the Confucianist philosophy which had now become sufficiently interesting to attract the best minds of the nation, who, from that time on, no longer flocked to the doors of the Zennist monasteries. And when the first-rate mentality of the nation ceased to be recruited into Buddhism, that great Indian religion gradually faded into nonentity and died almost an unmourned death.

But what was the real nature of this secular substitute for the Indian religion? Was it a real repudiation of the Buddhist religion as it claimed to be?

In reality, the Confucianist revival since the eleventh century has been only a *secularization* of the Indian religion. By secularizing it, the Chinese philosophers had actually *universalized* it, so that what had once ruled the life of the members of the Buddhist order was now able to extend its control over the whole non-Buddhist population through the teachings of the philosophers.

Prior to the Rational philosophers, Indianization was more or less confined to those who actually fled the world; but after the secularization of Buddhist ideals by the Rational philosophers, the rules of life of an other-worldly religion were seriously applied to secular life. The age of Rational Philosophy presented to us, not the human and commonsense atmosphere which one finds in the writings of Confucius and Mencius, but an austere and icy atmosphere of the medieval monastery. Indianization was universalized by being unconsciously appropriated by the philosophers and extended by them to regions never before seriously invaded by the Indian religion.

Let us first examine into this philosophy itself to see how much it differed from the medieval religions. This new philosophy has been formulated as consisting of two main paths: "To increase learning, one must extend one's knowledge to the utmost. For moral cultivation, one must resort to the attitude of reverence." (Cheng Yi, 1033-1107). The first road is intellectualistic; the second, moral and religious. "Reverence" to the ancients simply means taking things seriously. But to the Rational philosophers it has acquired a religious connotation. To be reverent now means to act in accordance with the Divine Reason. Now, what is that Divine Reason? The answer is: It is the opposite of Human Desire. And how can one know the Divine Reason? The answer is: the best way is through sitting in quiet meditation.

Even the other path, that of extension of knowledge, was not free from the religious impress of medieval China. To Chu Hsi (1130-1200), extension of knowledge was to be achieved through piecemeal investigation into the reasons of things—which was a strictly intellectualistic and scientific attitude. But, in the absence of the necessary equipment and of the experimental procedure, this was a difficult path, too difficult for the soft-minded majority of the philosophers who soon gave it up in despair and declared that true knowledge must come from within one's own mind and the approach must be through quiet meditation and introspection.

Bengal Medicinal Flora (Compositæ)

H. L. Chakravarti

Royal Botanic Gardens, Calcutta.

Name :—*Eclipta alba* Hassk.

Family :—Compositae.

Synonym :—*Eclipta erecta* and *prostrata* Linn ; *E. erecta* ; Lamk ; *E. erecta* and *alba* Dalz ; *E. prostrata*, Roxb ; *E. prostrata*, *undulata* and *parviflora wall* ; *Verbesina alba* and *prostrata* Linn.

Verncular Names :—Sans.-Kesaraja ; Hind.-Mochkand, bhangra, babri ; Beng.—Kesuti, Kesuriya, Keshwri, Kesaraya ; Oriya.—Kesarda ; Santal.—Lal kesari ; Sind.—Tik ; Mar.—Maka, bhringaraja ; Guj.—Kaluganthi, dodhak, bhangra ; Tam.—Karisha, langanni, Kaikeshi, Kaivishi-ilai ; Tel.—Galagara, Gantakalagara, gunta-galijeru ; Kan.—Garagada-sappu, Kadigga-garaga ; Sing.—Kikirindi ; Arab.—Kadim-el-bint.

Description :—A strigose slender weed. Stems erect or prostrate and often rooting at the nodes. Leaves sessile, 1-4 in. long but very variable, linear, or ablong lanceolote, narrowed at both ends, entire or serrate, strigose on both sides. Heads ¼-⅓ in. in diameter, solitary or 2 together on stiff unequal peduncles. Invol, bract, obtuse or acute, strigose outside, Ligules white, spreading, linear, not toothed. Achenes with 2 of the angles winged, the sides covered with warty excresences. Pappus O. or of a few minute teeth.

Habitat :—Throught India ; ascending to 6000 ft in the Himalaya and other mountains. Cosmopolitan in warmer climates.

Actual distribution :—(*i. e. exact localities from where the plant has been collected*) ;—

BENGAL :—Royal Botanic Garden, Calcutta and round about Calcutta ; Alipur Duars, Mahakalguri ; Agartala 600-800 ft. Hill Tipperah var. erecta ; Sibpore : Goalnundo, river bank ; Chirla, Sundriban ; Barkul, Chittagong hill tract ; Chittagong.

ASSAM :—Khasia ; Gowhaty var. prostrata ; Naga hills, var. erecta ; Assam Valley, Akha hills, var. erecta ; Dihing River, Makum ; Kohima 4700 ft, Naga hills ; Kamakhya, var. prostrata ; Sibsagar ; Lohit Valley Road ; Haflong 2000 ft, N. Chchar.

BEHAR :—Banks of the garden near Sahibganj ; Chota Nagpur ; Manbhum, var. prostrata ; Dorunda, Chota Nagpur.

ORISSA :—South end of Chilka Lake, var. erecta :

UPPER GANGETIC PLAIN :—Government Grass Farm, Allahabad, Vern. Ghamira ; Bettiah ; Banda N. W. P., var. prostrata ; Moradabad 800-2000 ft, Jaunpur.

CENTRAL INDIA :—Mahanadi, var. prostrata ; Jubbulpore, var. erecta ; Gwalior, var. erecta ; Marwar, Rajputana ; Mahanadi, var. prostrata.

PENINSULAR INDIA :—Rampa Chodavaram, Rampa District ; Sand river bed ; Barkuda Islands, Chilka Lake ; Travancore State ; Arakkampatti 850 ft, Madura Dt ; Kellegal, 2000 ft, Sullia, S. Canara Dt ; W. Coimbatore 1300 ft, growing in water ; Shevaroi hills ; Nilgiri hills ; Triplicane ; Musulipatam, Kistna Dt ; Madras, var. prostrata ;

EASTERN HIMALAYAS ;—Shivoke ; Pankabari.

NORTH WEST HIMALAYA :—Khybar Pass, found in the bed of Khybar stream ; Allmajid near Mussori, Hazara.

PUNJAB :—Ferozepore, var. erecta ; Campbellpore Peshwar ; Lahore.

CEYLON :—Colombo.

LACCADIVES :—Cardamum ; Kiltan :

SIND :—Karachi ; Cutch, var. prostrata.

AFGANISTAN :—Waziristan.

BURMA :—Fort Stedman ; Mree Hill, 3600 ft, Maymyo ; Loi Kaw Swam 3600 ft, Southern Shan

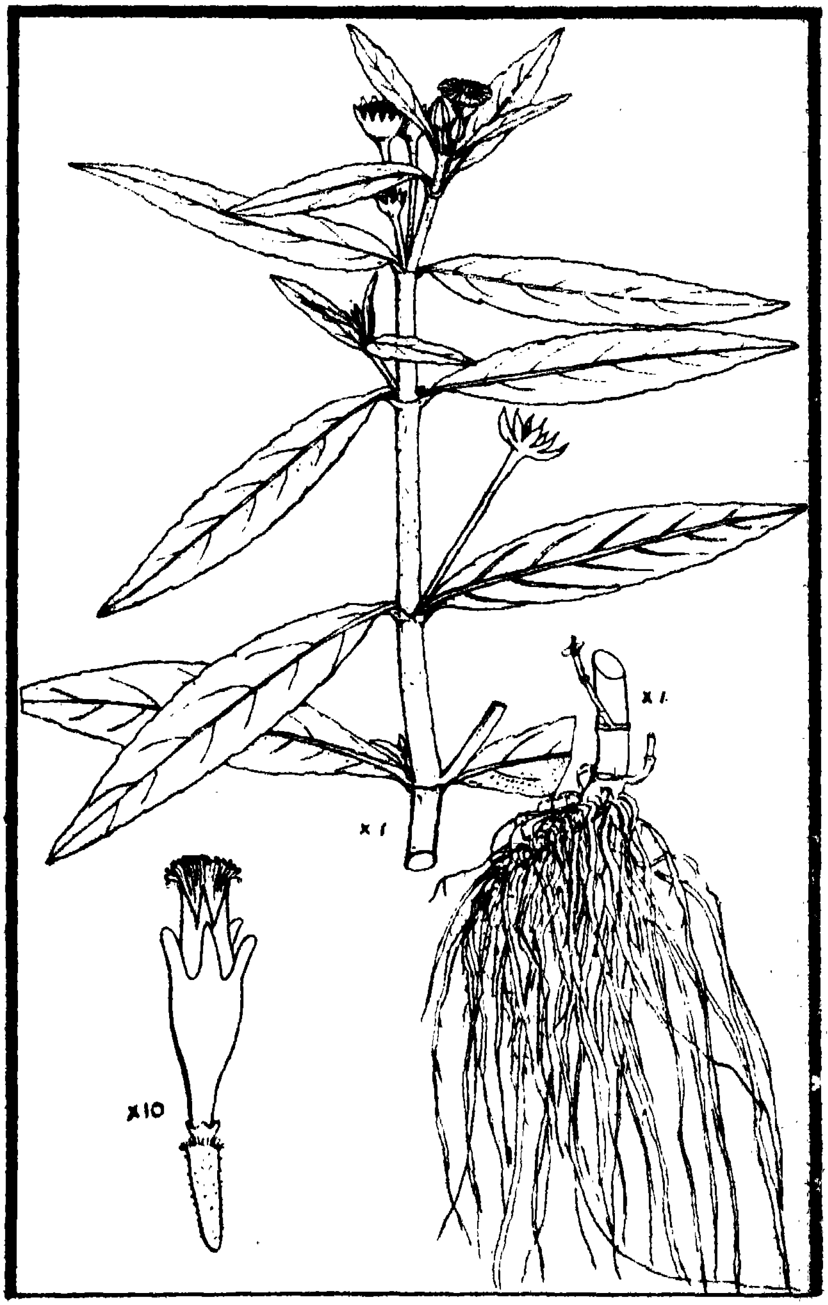
States; Kyoukmyoung: Shevebo; Minjoo; Kyonkse; Shan; Martaban; Moulmin, var. erecta; Gyn Village; Bhamo.

Andamans:—Palmonal; S. Andaman; Ross Island, S. Andaman, var. prostrata; Dhamikhari, hill jungle, S. Andaman.

Malay Peninsula:—Tharjury, Perak; Tulloh Bahang, Pulase, Penang; G. T. Penang; Malacca; Java.

Medicinal properties & uses:—It is an old established Hindu medicine, principally used as a tonic and deobstruent in heptic and splenic enlargement and in various chronic skin diseases; in the latter case, it is also pounded and applied externally. The expressed juice is recommended in the Pharmacopoeia of India as the best from of administration. In Bombay the juice is used in combination with aromatics, such as ajowan seeds, as a tonic and deobstruent and is given to new-born children suffering from catarrh in combination with honey in the proportion of 2 drops of juice to 8 drops of honey. It also forms an ingredient of a remedy used in concon for tetanus (Dymock). The fresh plant mixed with sesamum oil is applied externally in elephantiasis. According to Murray, the expressed juice of the root is employed as an emetic in Sind. It is also purgative. The Rev. A. Campbell states that in Chuttia Nagpur the root is applied in conjunctivities and galled necks in cattle.

Special opinion:—"The juice of the leaves is given in one-tea-spoonful doses in jaundice and fevers. The root is given to relieve scalding of the urine in dose of 180 grains mixed with salt" (C. T. Peters, M. B., Zandra, South Afganisthan). "It is anodyne and absorbent and relieves headache when applied with a little oil. It is an excellent substitute for taraxacum (Kanai Lal De, Bahadur).



ECLIPTA ALBA HASSK.

Dye:—There is a popular opinion that the herb, taken internally and applied externally will turn the hair black (Dymock). In tatooing, the natives, after puncturing the skin, rub the juicy green leaves of this plant over the part which gives the deserved indelible colour, *viz.*, a deep bluish black (Roxburgh). Dr. Kanai Lal De writes: "The practice prevails in Bengal of anointing heads of infants with the juice of the fresh plant to cause apparent greyish hair to become black. This is repeated once or twice, the hair being shaved. It is also used by the natives in scorpion sting.

Active principle :—Alkaloid ecliptine.

Reference :—*Phar. Ind.* Vol. III 268;

Roxb. *Fl Ind.* ed. C. B. C., 605; Thwatis. *Ceylon Pl.*, 164; Dulz and Gibs, *Bom. Fl.* 127; Stewart, *Pb.* 126;

Pheede, *Hort. Mal.* X., 41; Dymock, *Mat. Med. Ind.*, 2nd. Ed., 430. Aitcheson, *Cat. Pb. and Sind Pl.*, 75.

Professor Paul Debye

D. M. Bose
Palit Professor of Physics Calcutta University
M. N. Saha
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PROF. Paul Debye to whom the Nobel Prize has been awarded this year in chemistry is a Dutchman by birth, but is a German by adoption. He was a student of engineering about the year 1910 at Munich, but he chanced to come into contact with Sommerfeld, under whose magnetic influence he began to study physics. He has been successively professor at Göttingen, Zurich, and Leipzig, and is now Director of the Kaiser Wilhelm Institute in Physics, Berlin, Dahlem.

Though awarded the Nobel Prize in Chemistry, Prof. Debye's contributions have been mostly in physics. Like the late Lord Rayleigh he combines a clear physical insight with great powers of mathematical analysis, with which he has succeeded in clearing up many obscure problems regarding the structure of matter, and interactions between matter and energy. Many people have deplored the fact that Debye has not taken a more active interest in the modern problems of quantum physics. Classical physics and chemical physics have been the gainer by this. We give below a short account of Debye's investigations.

Debye was once described by Prof. Langevin as *Physicien Comple't* for he has worked not only on theoretical physics, but he is also the inventor of very fine methods of experimental investigations.

Debye's Theory of Specific Heat

In 1910, it had been known, through the researches of Nernst and his pupils, that the specific heats of most solids tend to become zero as the absolute zero of temperature is approached. Einstein gave an explanation of this variation of specific heat with temperature by supposing that the atoms in an elastic solid perform oscillations of frequency ν, thereby absorbing and emitting quantum of energy $h\nu$. The formula derived gave only a qualitative account of the observed phenomenon. In 1913, Debye introduced the assumption that the heat energy of a solid exists in the form of stationary acoustic waves of different frequencies each having its appropriate quantum of energy. By this means he gave a much better quantitative interpretation of the phenomenon. It has been found in recent years, as the absolute zero has been reached, more discrepancies occur and the phenomenon requires a more comprehensive explanation. Debye's theory of specific heat of solids had about 23 years of life but has probably many more years to run. This conception of heat energy of a solid or liquid body existing in the form of an acoustic spectrum has been fruitful in many directions. Brillouin has used it to explain the scattering of light in transparent solid. The idea has been used to explain the fine structure of Rayleigh lines scattered by liquids. Following up this idea in 1932 Debye and Sears and also Lucas and Biquard were able to show that ultrasonic waves in a liquid medium were able to produce a diffraction effect on light waves similar to that by three dimensional grating.

Electric Moment of Molecules

Debye was the first to give a satisfactory explanation of the temperature variation of di-electric constants of a certain class of substances known as polar. Suggested by Langevin's assumption of permanent magnetic moment in the molecules of paramagnetic substances introduced to explain the temperature variation of paramagnetic susceptibility, he assumed that in this class of polar substance the molecules possess permanent dipole moments. With the help of this assumption he was able to account for the observed temperature variation and also to determine the dipole moments of such molecules. This work has been of great importance in helping to determine the structure of a large group of organic molecules. Introducing further the idea of a molecular field he has been able to explain the deviation of the observed dipole moments of these molecules in the liquid state from those in the vapour state. This line of work has been of importance in interpreting the phenomena of association of molecules in the liquid state.

Marching towards the Absolute zero

In 1925 Debye wrote a masterly report on the electric and magnetic properties of matter in the *Handbuch der Radiologie*, in course of which he subjected Langevin's theory of the orientation of paramagnetic molecules in a magnetic field and Weiss's theory of molecular field to a critical analysis. He later on followed up this work and showed in 1926 that Langevin's formula for the magnetic susceptibility cannot be correct as this leads to an infinite value for the entropy at absolute zero in violation of Nernst's Heat Theorem. In course of this article he deduced an expression for the adiabatic lowering of temperature of a paramagnetic body due to demagnetization and he suggested how the effect could be utilized for further reducing the temperature of bodies below the liquid helium temperature. The idea was independently arrived at by Giacque and later Keesom, and others have utilized the principle in their attempts to approach the absolute zero of temperature.

X-Ray and Electron Diffraction

Another problem which has always interested Debye was the exploration of atomic and molecular structure by means of light and X-ray. Results deduced theoretically by him were used by his co-workers to determine experimentally the structures of a class of molecules in the vapour state and of gases by means of X-ray and electron diffraction patterns. He also made an important contribution to the theory of X-ray scattering by crystalline powders and later devised the well-known Debye-Scherrer method of determining structures of crystals. In continuation of this line of work Debye in 1926, almost simultaneously with Compton gave the correct interpretation of the observed softening of X-rays scattered by light atoms, for which Compton was awarded the Nobel Prize.

The Electrolytic Theory of Debye and Hueckel

About 1920, a great deal of attention was aroused by a theory of electrolytic dissociation proposed by Prof. J. C. Ghosh of Dacca, in which the assumption was made that in strong electrolytes the dissolved salt and strong acids were completely dissociated as opposed to Arhennius's idea of dissociation increasing progressively with dilution. Debye and Hückel took up the problem and with great deal of mathematical skill and physical acumen worked out the results in a more quantitative form. This theory has been able to represent quantitatively a large number of properties of strong electrolytes in the state of high dilution. But the properties of more concentrated solutions still await satisfactory interpretation.

Producing White Dwarf

One of the writers of this note had the pleasure of meeting Debye several times in his European travels. He met him recently in the Harvard Tercentenary where he was awarded an honorary degree. In course of a conversation he told one of us that he was engaged in making a bit of a white dwarf. Probably the reader knows that astronomers have discovered a system of bodies in the heavens which are known as white dwarfs, in which the density of matter may be 60,000 times, nay, even a million times, that of platinum which is the heaviest metal known on the earth. How does this thing take place ? Matter must be existing inside these stars in a form which is not known to us on the earth. It is well known that the atom which we know on the earth consists of the nucleus with a positive charge surrounded by a shell of electrons. On subjecting matter to compression, the diminution of volume which takes place is opposed by the mutual repulsion of the electron shells and atomic nuclei. Further increase of pressure will then lead to the successive stripping of the electron shells, till in the limit we have nothing but the stripped nuclei occupying an extremely small volume with free electrons lurking between them in an unknown form. This pressure ionization is supposed to exist in white dwarfs. This kind of effect is rendered probable by the existence of neutrons, the new elementary particle discovered by Chadwick in 1932. This neutron is of extremely small dimension and it has been found to be a constituent of all nuclei. Further the neutrons and protons appear to have strong attraction for each other when very close. In white dwarfs, therefore, most of the matter probably consists of agglomeration of neutrons and protons. Debye proposes to produce this state by a novel experiment. He will make a cyclotron, an apparatus which has been invented by Lawrence of California and is found to give us a very copious supply of neutrons. These neutrons will be shot into a path which is maintained at absolute zero of temperature. Debye thinks that neutrons will then cling to each other and will form a sort of a compact mass which, volume for volume, will be million times heavier than ordinary matter and will thus be a piece of white-dwarf matter. The experiment is on too ambitious and bold a scale, but it can be expected that Debye will utilize all ingenuity of modern physics to carry it out. Recently it has been found that the neutron is unstable when left to itself. Probably it spontaneously gives out an electron and is converted into a proton. If this is true, it may not be possible to compress neutrons into white-dwarf matter. Let us wait and see.

A versatile genius, equally skilled in theory and experiment, and master of a number of European languages, Debye has shown that there still remains much to be done in classical physics.

Victor Hess and Carl Anderson

REUTER'S message announces the award this year of Nobel Prizes in Physics to Dr Victor Hess of Austria and Dr Carl Anderson of the Norman Bridge Laboratory, Pasadena. The awards have undoubtedly been made on the recognition of the pioneer work made by Hess twenty years ago on a phenomenon which has now acquired wide celebrity as *Cosmic Rays*. The award to Dr Anderson is in recognition of his discovery of the positron (*i. e.* the positive unit of electricity) which was a by-product of the work of the Millikan school on cosmic rays.

Victor Hess, Discoverer of Cosmic Rays

Like many other great discoveries, the discovery of cosmic rays is based on the observation of certain obscure phenomena. In 1903, Elster and Geitel in Germany, and C. T. R. Wilson in England showed that normal air, though usually regarded a a non-conductor of electricity, shows a small amount of conductivity, or as we say now, *air is slightly ionized.*

It was shown by Rutherford and Cooke in Montreal, and McLennan and Barton in Toronto that even when air is confined in a closed space so as to shield it from all possible sources of ionization it shows a certain amount of conductivity. The causes of this residual ionization could not be understood for a very long time; for a time it was supposed that this residual condition of electricity in closed air was probably due to the possibility that there was in the containing vessel some radio-active impurities which emitted rays causing ionization of enclosed air. Then experiments were made by enclosing air within vessels which contained no radio-active impurity, but it was found that even then, the same residual ionization persisted. It was then supposed that it was due to highly penetrating radiations (like the γ-rays from some radioactive matter) from air or from the ground and that these radiations passed right through the vessel. In 1909, Wulf from certain experiments discovered that the residual ionization of closed air can be detected even on the top of towers. After Wulf, Gockel undertook certain number of pilot balloon observations, in which he showed that the residual ionization of closed vessel increases with height, so that they cannot be due to some radio-active rays coming from the air or from the ground. To elucidate the matter further, Hess undertook a certain number of balloon expeditions in 1912 and 1913, which showed that the intensity of these rays goes on increasing as we ascend higher up in the atmosphere. At 4 kms the intensity becomes tenfold.

To account for these phenomena, Hess propounded the hypothesis which appeared very bold at the time, that this residual ionization of air in closed vessels was due to certain kind of unknown and mysterious rays from space. He called them *Ultara-Strahlen* or ultra-rays. This interpretation of these mysterious rays causing residual ionization of closed air has remained true up to the present time and have led to an immense number of experimental work in the laboratory, and observations in balloons, stratosphere gondola and over all parts of the world, but the name ultra rays has given way to the more catching name cosmic rays invented by Millikan in 1925.

But after the war Kolhörster in Germany and Millikan in America undertook these experiments over again. Millikan at first thought that the Hess effect was spurious, but further improvements in his apparatus convinced him in 1925 that the rays are real and he forthwith christened these rays as cosmic rays i. e. rays coming from the great Cosmos. It is not true, as ill-informed newspapers in certain quarters hold that he was the discoverer of these rays. The award of this year's Nobel Prize settles the controversy once for all, and gives the credit for the great discovery to Victor Hess, who took the first step to the elucidation of the mystery in a boldly planned balloon flight nearly quarter of a century ago.

The cosmic rays have received so much attention in the papers that almost all the newspaper readers are familiar with them. There is still a certain amount of uncertainty as to the nature of the cosmic rays. Millikan had proposed the theory that they consisted of high energy photons. The experiments of Bothe and Geiger showed that at sea level a part at least of the penetrating rays must be of corpuscular nature. The further discovery that the intensity of the cosmic rays vary with the geomagnetic latitude, first observed by Clay and later verified by Compton, Millikan and others, has led to the view that the cosmic rays as they enter the earth's atmosphere must contain a large fraction of charged particles, protons, electrons etc. That these charged particles are predominantly positive is shown by the existence of the east-west symmetry. Anderson first showed the existence of positrons amongst the latter, while presence of protons and α-particles has been made probable by cloud chamber observations at high altitudes and by stratosphere observations. Geiger and Funfer have tried to give a systematic account of the cosmic ray phenomena including secondary effects on the assumption that the primary cosmic rays consist of high energy charged particles which are converted successively into photons, electron pairs etc. The theory cannot satisfactorily account for the presence of the so-called 'showers' and 'bursts.' Recently Heisenberg has extended Fermi's theory of α – ray disintegration to give a qualitative picture of shower formation. Future investigations will have to develop quantitatively Heisenberg's theory and test it experimentally.

Carl Anderson, Discoverer of the Positron

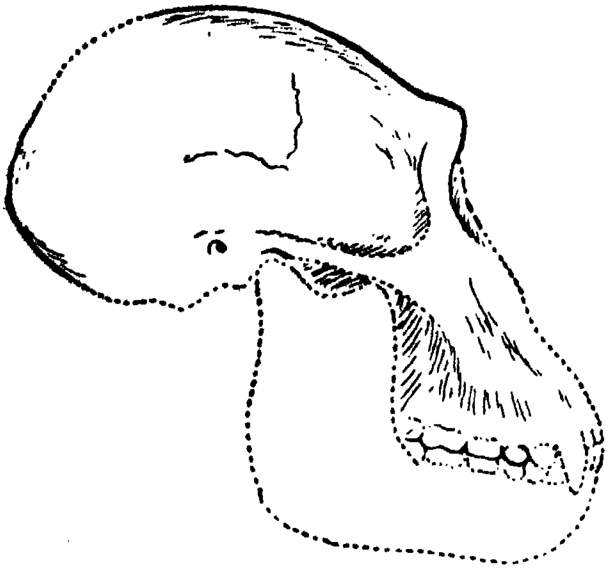
Dr Carl Anderson, the second recipient of the Nobel Prize, is a young pupil of Millikan. In 1931, when trying to photograph the cosmic rays in a magnetic field according to the method of C. T. R. Wilson, and first used for this purpose, by Skobelzyn, a Russian worker, he made the discovery of the positive electron. The discovery was long overdue, as a matter of fact the writer of this note was told in Europe that the discovery was first made by Madame Irene Curie and her husband M. Joliot in Paris sometime before Anderson and also by Blackett in Cambridge, but they had some hesitation in publishing their results as most people thought that there could be no positive electrons; for it was supposed that electrons have a negative charge. As a matter of fact, a great physicist to whom the results of Curie-Joliot were communicated said that the observation must be either spurious, or must have been due to electrons entering the Wilson Chamber from the wrong direction. But Dirac had predicted the existence of 'positrons' from his 'hole theory' in 1930, and a knowledge of this emboldened Anderson to make his discovery known to the public. Anderson further verified the existence of positrons by performing two supplementary experiments. He interposed a thin lead sheet in the cloud chamber in the path of the charged particles, and found that the curvature of the track increases on passing through the sheet. This shows that the sign of the charge must be positive, secondly from the radius of curvature and the density of ionization along their tracks he inferred that its mass was nearer to that of the electron rather than that of the proton. Probably the other observers of this effect did not think of making these crucial tests. The positron has since been obtained from artificially radioactive bodies and from the fission of γ-ray quanta and their existence is no longer doubted.

M. N. S.

"A New Ancestral Link between Ape and Man"

B. S. Guha
Anthropologist, Zoological Survey of India, Calcutta.

A discovery of unusual importance on the question of human pedigree has just been announced by Dr. Robert Broom, F. R. S. of the Transvaal Museum in the latest issues of the *Illustrated London News* and *Nature* (Sept. 19, 1936). In the course of the blasting of the lime-stone caves at Sterkfontein near Krugersdorp, in Transvaal (lat. 26.5 S and long. 27.40 E), Mr. G. W. Barlow, Manager of the Lime Works, recently discovered the fossil remains of an adult anthropoid ape belonging to the same genus as the Taungs ape or *Australopithecus africanus*, but probably of a different species. The vault of the cranium has unfortunately been destroyed by the blast, but the greater part of the two parietal and the occipital bones, the anterior two thirds of the brain-cast resting on the skull base, the right maxilla along with the second premolar and the first, second and the third molars were found in a perfect state of preservation. As yet the bones have not been freed from the hard matrix, but the preliminary examinations show that the greatest antero-posterior and the transverse diameters of the skull were about 145 mm. and 96 mm. respectively with an approximate cranial capacity of 600 c. c. The brow ridges are moderately developed with large frontal sinuses (see fig. I). The socket of the canine which is preserved, shows that the latter could not have been large. The size and the pattern of the first molar with four well developed cusps and a well developed posterior fovea are typical of *Dryopithecus rhenanus*, though not quite unlike the first molar of the Neanderthal Man, but the second and third molars are much too large (14.5 mm. × 16 mm. and 13.7 mm. × 15.5 mm. respectively) for man or any of the living apes except the Gorilla. While *Australopithecus africanus* belonged to a Lower or Middle Pleistocene deposit, *Australopithecus transvaalensis*, as the Sterkfontein ape is provisionally named by Dr. Broom, was apparently of the Upper Pleistocene. It is of course too early to understand the full bearing of this discovery on Human Evolution but the large size of the brain and the form and pattern of the teeth, would appear to indicate that the Sterkfontein ape having distinct relationships with the Pliocene species of *Dryopithecus* was very near to the line from which Man had evolved.



Text Fig. I.

Attempted restoration of Australopithecus transvaalensis by Broom, (half size), (from *Illustrated London News*).

Notes and News

Allahabad University Annual Report

According to the annual report of the Allahabad University, there was a slight dicrease during 1935-36 in the number of admissions in the Faculty of Arts and the Law Department. The number of scholars at the end of the year was 1,930 as against 2,096 for the preceding year. The percentage of post-graduate students to the total number on the rolls, excluding law students, was 21. Research scholars and students increased from 28 to 31. The scheme of teaching a two years' course in military science to student-members of the U.T.C. having been sanctioned, arrangements had been made for holding the examination. The theoretical examination will be held in January 1937. The M.A. examination in Economics, hitherto governed by the ordinances under the Faculty of Arts, had been transferred to ordinances under the Faculty of Commerce. The General English papers for the B.Com. examination from 1938 would be the same as those for the B.A. examination. The ordinances regarding the admission of students to University examinations had been slightly amended with a view to allowing a period of grace not exceeding ten days in the case of students short of the college or hostel attendance. The title B.A. III year had been changed to M.A. The ordinances for the degree of D. Sc. and D.Litt. had been thoroughly revised, and a lower research D.Phil. degree had been instituted under the Faculties of Arts and Science. A diploma examination in music had been instituted, and the first batch of candidates would appear in April 1937. The classes had been thoroughly reorganized and the teaching staff strengthened by the appointment of new teachers.

Discoveries in Numismatics

In the course of his presidential address to the Numismatic Society of India held this year at Udaipur, Dr K. P. Jayaswal, referring to two coins found at Madhuri in the Shahabad district, opined that they may belong to some pre-Mauryan dynasty. The discovery of Kushan coins in North Bihar throws light on the extent of the Kushan empire. The important discovery of coin moulds at Rohtak by Professor B. Sahni of Lucknow reveals the technique of casting coins. Eight coin mounds are arranged on a disc- round a central hole. The reverse and obverse discs were laid in piles of several pieces and metal was poured into the central hole, reaching the sockets through eight small channels radiating from the central hole. The coins produced read *Yandhena Bahudhânyaka*. Coins and inscriptions, read along with the *Mahabharata*, establish that the whole of northern Rajputana, the eastern Panjab and the land up to the borders of Kurukshetra were under the united states of the Yandheya republic in the early centuries of Christian era. It is suggested that the Yandheyas have survived as the predominant element of the population of Rajputana.

At the site of the ancient Śrâvasti have been discovered coins dating from the pre-Śunga times, some of which have the place-name *Savati*, proving that the place was a mint-owning provincial centre in the pre-Christian centuries.

Sir Jagadis Chandra Bose

On the occasion of his seventy-eighth birthday which took place on the 30th November last, we offer our warm felicitations to Sir Jagadis Chandra Bose, F.R.S., director and founder of the Bose Research Institute of Calcutta. The scientific researches of Sir Jagadis, both in the field of physics and plant physiology, and generally on problems of life, spreading over a period of more than forty years, excited great interest and admiration in the Western countries, and, as a recognition of his pioneer work, he has been the recipient of various honours from the whole world. His indefatigable energy and an inextinguishable thirst for knowledge have marked him out as an eminent scientist of the world, and surely one of the few oldest original workers of India.

Professor S. S. Bhatnagar and Oil Research

Public is already aware that for some time past Professor Bhatnagar of the Punjab University has been carrying on valuable investigations on oil on a grant from Messrs Steel Brothers of London. Messrs Steel Bros. have been so satisfied with the work already done that they have recently announced their intention of extending their grant to ten years, so as to enable Prof. Bhatnagar to go on with his oil research scheme. This extension practically means more than doubling the original donation. The Company hopes that the research will yield results valuable not only to oil technology but to pure science as well. We understand that the offer has already been accepted.

Economic Development in the United Provinces

The United Provinces Economic Planning Committee, consisting of Khan Bahadur Obaidur Rahman (chairman) and Dr Radhakamal Mukherjee, Prof. S. K. Rudra, Prof. Gurmukhnihal Singh, and Lala Hariraj Swarup (members) has drawn up financial recommendations for one year in the first instance.

The committee suggests that the programme of economic planning should be dual; intensive planning in a number of circles of 15 villages each in every district; and demonstration work of a broadcast kind in every village. For this purpose it recommends the establishment of a provincial board of economic inquiry and planning and district development boards, village panchayats and co-operative societies, the appointment of a rural development commissioner and three assistant commissioners for inspection and supervision work, as also of inspectors and village organizers in every district. In areas where the majority of the holdings are undersized the first task of agricultural planning should be consolidation. If 33 per cent of the landlords and tenants apply for consolidation the village should be consolidated. Amendments to the Tenancy and Land Revenue Acts are suggested for this object. Consolidation of cropping should also be encouraged. Judicious crop-planning propaganda in the cane areas and fixing of definite quotas of sugar cane areas in each province are suggested. Legislation on the lines of the Bombay Act should be passed for the castration of all unfit and useless animals. In forest divisions tracts should be laid aside for cattle breeding and improvement. Co-operative Societies and milk depots should be established in suitable centres and cold storage vans should be provided on fast trains to promote dairy industry.

Facilities for technical guidance and research and grant of concessions such as cheap supply of raw materials under Government control, canal water, etc., should be offered for certain pioneer industries. The manufacture of paper, sheet glass, paints and varnishes, shellac, cement and power alcohol can be developed in various parts of the province with the help of Government assistance. An industrial survey of the province is recommended. The committee also suggests that the Provincial Board of Communications should be reconstituted into a Board of Communications and Marketing. A Highway Act for the province and greater co-operation between the Irrigation Department and the district boards are desirable. For encouraging motor transport grant of monopolies by public auction for limited periods is recommended. Construction of light railways or tramways for the transport of cane bricks and forest produce in suitable areas should be included in the programme. A small tax on tobacco is suggested for rural reconstruction if the funds from other sources are not adequate.

The recommendations of the committee are well thought out and, we have no doubt that they will go a long way to improve the present sad conditions of the village life in the United Provinces, if they are effectively carried out. These provinces are to be congratulated on their pioneer efforts and we hope that other provinces will also follow suit soon and draw up plans on similar lines for the amelioration of their rural conditions. The recommendations of the U. P. Committee are more or less wide in their scope and can be applied with advantage to all parts of rural India.

Medical Facilities in Rural Areas

In order to encourage qualified medical practice in rural areas and provide better medical facilities, the United Provinces Government have wisely decided to increase the subsidies payable to medical practitioners under the scheme introduced in 1925. A medical graduate, engaged under the scheme, will now receive a subsidy of Rs 1000/- per annum instead of Rs 600/- as at present, and a medical licentiate Rs 600/- a year instead of Rs 400/- as at present. These subsidies, will be exclusive of the amounts paid for the maintenance of qualified midwives or nurses and of the district boards' contribution of medicines to the value of Rs 360 per annum to each doctor. This decision of the Government has been communicated to the district boards in the U. P., who have invited applications from eligible candidates. The work of practitioners receiving subsidies will be more thoroughly inspected in future, and the value of results achieved will be filed. The Government, with this end in view, has directed every Civil Surgeon to inspect annually the work of all subsidized practitioners in his district, the results of which will be incorporated in the annual report of the Inspector-General of Civil Hospitals.

New Exhibits at the Science Museum

Among the recent additions to the Science Museum, South Kensington, London, are an original tube of the metal rhodium prepared by its discoverer Dr William Hyde Wollaston, about 1825; and the Oxford Heliometer of 1848. Rhodium is now attracting a great deal of interest as a non-tarnishing substitute for silver in electroplating. Oxford Heliometer was made for the Radcliffe Observatory, Oxford, by Messrs A. & G. Repsold of Hamburg on the advice of the famous German astronomer F. W. Bessel who had in 1838 with a similar instrument obtained the first satisfactory measure of the parallax (distance) of a fixed star. The distance of the star, 61 Cygni, was found to be some 400,000 times the sun's distance of 93,000,000 miles. The Oxford Heliometer was for many years one of the most powerful and accurate instruments of its kind in the world. It is notable among other things for the first application of electrical illumination to an astronomical instrument.

Public Health in Assam

The report on public health in Assam for 1935 reveals an increase in the death-rate and a decrease in the birth-rate which fell from 30.62 per thousand to 30.26 and the former rose from 33.67 to 37.33. Cholera was responsible for 7,436 deaths in the districts in the plains and 2,315 cases and 1,149 deaths in Manipur State. Smallpox took a toll of 529 lives against 206 in the previous year. The number of deaths from typhoid rose from 42 to 56. The number of kalaazar cases fell from 13,398 to 11,100, but deaths increased from 770 to 846.

The year was a bad one for malaria. The Assam Medical Research Society had completed most of its surveys and was engaged on the useful work of planning on the basis of the data obtained. It appeared probable that in many of the malarious regions, application of anti-larval methods during the cold weather and pre-monsoon months, before the rains begins to act as a natural flushing agency, will constitute a cheap system of control. There were 61 dispensaries equipped for the treatment of leprosy, and 2,305 cases were treated. Attempts made to operate the Pure Food Act without a special staff of food inspectors did not prove encouraging. The Local Boards have not hitherto made any efforts to enforce its provisions outside the towns, and a considerable proportion of prosecutions failed from one cause or another, or resulted in light penalties.

U. P. Unemployment Relief

The secretary to the Industries Department, United Provinces, placed before the Legislative Council a statement showing the action taken by Government on the report of the United Provinces unemployment committee. The statement covers the stage reached by each of the schemes undertaken up to the end of October, 1936.

Sixteen students were selected for practical training in agriculture but only 13 have actually joined farms. Seven others will be selected by the Director of Agriculture from among applicants and students of the Agricultural College. The scheme for instruction in estate management has been held up owing to the fact that no changes in the Cawnpore Agricultural College curriculum can be made without the approval of Agra University. The question of fitting in such instruction with ordinary tutorial work is under examination. Three students for a two-year course for a dairying diploma have been selected and are under training at the Agricultural Institute in Naini Tal and the selection for a six-month course in organized supply of milk and milk products will be made before that course is due to begin. The syllabus for training in organized supply of eggs, poultry, etc., has been drawn up and the selection of suitable candidates desirous of undergoing training is expected to be completed soon. Students have been selected for deputation for veterinary training. Six centres of agricultural improvement in canal areas have been set up and work has been started.

As regards medical relief a district health scheme has been extended to four districts and three travelling dispensaries have been revived. Some of the rural dispensaries to receive grants have been selected. An additional grant has been placed at the disposal of the Board of Indian Medicine and applications have been invited from promising medical graduates and licentiates willing to settle down to medical practice in rural areas.

Under heads not involving additional expenditure a committee under the chairmanship of Sir Tej Bahadur Sapru has been set up and the secretary has started preliminary work in connexion with educational reorganization. The Government have issued orders asking the Director of Public Instruction to set up advisory committees charged with duties of advising students as to careers and of endeavouring to find employment for former students of the institution. The question of reform of legal education is under examination in consultation with universities.

Gift to Patna University

The Chancellor of Patna University has accepted the offer, contained in the will of the late Rai Bahadur Bindeswari Prasad Singh of Dharbanga, of an annual sum of Rs 2,500 to be paid to the university for establishing a chair or readership of pure Hindi literature and it has been decided to appoint a lecturer in Hindi for M.A. classes at Patna College for the 1937-38 session.

Steel Research Laboratories for Tata Works

The foundation stone of the building of the new Tata research and control laboratories was recently laid at the Tata Iron and Steel Company's works at Jamshedpur by Mr A. R. Dalal. It is understood that the laboratory will cost a sum of ten lakhs of rupees and is designed to meet the growing demands of the Steel Company for the next twenty years. It is claimed to be the largest of its kind attached to any steel plant in the world.

In course of his speech Mr Dalal remarked that no manufacturer can maintain his position in this competitive world without research for keeping pace with the technical progress that is being made all over the world. In India the manufacturers have to work under the disadvantage that they have to provide for their own research; while in Europe and America, besides the laboratories of individual manufacturers, there are large centralized institutions carrying on research work for the industry as a whole.

The new laboratories when completed will be able to deal with research on following lines:

Control of raw materials, involving analytical and chemical problems, for purposes of selection or investigation.

The study, observation and supervision of all metallurgical operations carried out within the steel plant.

The properties of special irons and steels.

Refractory materials.

Corrosion problems.

Development of new steels and new products of all kinds.

Two special features of the laboratory are the air conditioning plant and the fume extraction plant which is of an entirely new design and an advance on usual standard practice. Incidentally, the building will use about 400 tons of Tata steel.

Plan of the Laboratory

We give below some details regarding the plan of the above laboratory. The metallurgical department occupies the basement and ground floor space in the north-west and west portions of the new building. This department will comprise the metellurgical laboratories, the statistical section, the routine physical test laboratory and the inspection department.

The basement, in addition to providing room for the air-conditioning plant, switch gear, etc., will also accommodate the routine physical test laboratory together with an adequately equipped machine shop for the preparation of the test pieces. A special room is also provided in the basement for conducting creep test experiments.

A steel melting and heat treating room is equipped with a high-frequency induction furnace of 50-75 lbs. capacity, for making small experimental heats of special steels. Adequate equipment for laboratory heat treating will also be provided in this room for experimental determination of the physical properties of the material due to varying heat treatments. This room is fitted with an overhead runway for facility in the handling of materials.

A micro-room is provided where sections received for micro-examination are delivered after duly machining and polishing the surface. Deep etching or sulphur printing is then carried out as desired to reveal the soundness, segregation and general structure of the material. The special test laboratory is fitted with a full range of standard machines for testing mechanical properties.

A physics laboratory has been provided where equipment will be installed to provide thermal and physical data for the various works departments and for the purpose of research dilatometric determinations of the volume changes in steels; co-efficients of linear expansion may also be determined. This room can also be used, later, for work on spectroscopy and X-ray examination of metals.

The chemical laboratories occupy the ground floor on the north-east and east. A corrosion laboratory is attached to the special chemical research room. This room will be entirely devoted to the carrying out of accelerated laboratory corrosion tests on various grades and qualities of steel. The chemical laboratories are composed of sampling rooms for preparing various samples for analysis, rooms for the preparation and standardization of reagents and various standard solutions, chemicals and apparatus stores, sample store and nine different working halls for carrying out analyses and tests.

The largest of the working halls may be called the general laboratory where refractory materials, stones, various rocks and minerals including ores and fluxes and other miscellaneous materials will be analysed. This laboratory for the analysis of the various types of steel and non-ferrous metals and alloys is provided. A fuel laboratory for carrying out physical and chemical tests on fuels such as coke, coal, tar, etc., is equipped with a balance room between the fuel and the metal laboratories.

The laboratory for gas analysis and calorimetry is adjacent to the fuel laboratory, while the laboratory for carrying out chemical analysis by physical methods is adjacent to the metal laboratory. Analysis of non-ferrous alloys by methods of electrolysis, spectroscopic, photometric, potentiometric and other physical methods of chemical analysis will be carried out in this laboratory. The combustion room is exclusively meant for carrying out tests requiring combustion methods. The oils and paints laboratory will take care of the various lubricating and other oils, greases and paint materials submitted for test and analysis. There is also a small laboratory for the chemist in charge and, finally, a special laboratory where all investigation work will be carried out.

Scholarship to Indian Students

In the editorial article of SCIENCE & CULTURE February, 1936, the work of the Commissioners for the London Exhibition of 1851, was fully discussed, on the basis of their latest report. After the great London Exhibition of 1851, a large surplus fund had been left which the Commissioners were given the power to deal with in any way they considered most likely to promote the knowledge of science and art and their applications to industry. The Commissioners used to award, out of this fund, a number of research scholarships to students from British Universities and Dominions. Five scholarships were reserved for Great Britain, three for Canada, two for Australia, and one each for New Zealand, Irish Free State and South Africa. Although the princes and people of India had contributed largely to the funds of the 1851 Exhibition, India had no place in this scheme of scholarships. We are glad that at last the Commissioners have decided to award one scholarship annually to India. Below we give the details of the offer.

The Royal Commissioners for the London Exhibition of 1851 have offered to provide for an annual science research scholarship of £250 to £300 per annum, tenable for two years, for students from universities in India.

The Commissioners have for some years been awarding such scholarships which are intended to enable selected students who have already completed a full university course and given evidence of their capacity for scientific investigation, to devote themselves for two years to research work under conditions most likely to equip them for practical service in the scientific life of the Empire.

The Commissioners now desire that universities and institutions of similar standing in India which have made provision for post-graduate work in science, should be given an opportunity of recommending candidates for the scholarships.

The Government of India have accepted the offer of the Commissioners with thanks.

The number of such candidates from among whom the scholarships committee of these bodies will have to choose one, must not be more than six.

The Government of India have decided to set up a small committee to make the preliminary selection of candidates.

Local Government and Administrations have been asked to invite nominations from Universities and from other suitable institutions for the scholarships to be awarded in 1987 and to make recommendations to the Government of India by March 1, 1987. No recommendations made after that date will be considered. Nominations are to be limited to persons whose record and aptitude encourage the expectation that they will do credit to India.

The standard to be attained by successful candidates is approximately the same as that required for a good Ph.D. degree in the United Kingdom.

Biochemical Standardization Laboratory

In March 1927, a resolution was adopted by the Council of State recommending that local Governments should be urged to take steps to control the *indiscriminate use of medicinal drugs and for the standardization of the preparation and the sale of such drugs.* Accordingly, in consultation with the local Governments, a committee was appointed, presided over by Lt.-Col. Chopra, to explore and define the problem of drug control and to make recommendations. The recommendations of this committee were considered in consultation with the local Governments, and action is now being taken to implement them by establishment of a Biochemical Standardization Laboratory for which orders have already been issued by the Government of India.

It may be noted that the control of drugs is primarily a matter of provincial concern, and under the new Constitution will be even more so. Central legislation or any other action taken by the Central Government alone cannot, in the circumstances, suffice to meet the problems disclosed. Though adequate action could not be taken so long owing to the existing financial stringency, in view of the increasing gravity of the problem and the interest it has evoked from representative commercial and medical organizations, as well as from the public, the laboratory is being established as a first step towards dealing with this problem and assisting local Governments to make their own preparations.

The laboratory will evolve definite norms or standards, but with its establishment, it is hoped that there will be the beginning of control over the manufacture of spurious drugs, to be implemented by suitable provincial action for the examination of drugs, patent medicines, etc., the norm or standards set up by the central laboratory providing the provinces *with a basis on which adequate steps can be taken to enforce local laws against adulteration.*

The laboratory will consist of a bio-assay sub-section and a pharmaceutical sub-section, and among its functions will be the preparation and maintenance of suitable standards of strength, purity and quality for drugs, and standardization of methods of analysis and test *with regard to climatic and other conditions prevailing in different parts of India.* The laboratory will also act as "expert referee" in respect of disputed analyses of samples sent by local Governments; guide, co-ordinate and correlate the work of provincial laboratories; assay and test chemicals and drugs, biological products such as serum and vaccines and organometallic compounds, at the request of the Central or local Governments; periodically issue bulletins about its progress in various branches of its activities; and supply information to manufacturers and provincial laboratories.

The laboratory will, to commence with, be located at the All-India Institute of Hygiene and Public Health Calcutta, and Lt.-Col. R. N. Chopra, I.M.S., Director, School of Tropical Medicine, Calcutta, will be responsible for its organization and direction in the early stages.

The staff of the laboratory will consist, besides a number of assistants, in its bio-assay sub-section, of one pharmacologist and two experimental assistants, and in its pharmaceutical sub-section, of one pharmaceutical chemist, one bio-chemist and two assistant chemists, and steps have already been taken for their recruitment.

Bihar Unemployment Committee

The report of the committee appointed by the Government of Bihar to examine and report on the nature and extent of unemployment among the educated classes in Bihar has been published.

Regarding the extent of unemployment the committee opines that the problem is not yet so acute in Bihar as in some other provinces. It is estimated that the number of matriculates in excess of the requirements of Government, local bodies, banks and private educational institutions would be about 800 each year, most of whom could be absorbed in the industries and railways of the province if outsiders could be excluded. The output of I.A.'s., I.Sc's., graduates, M.A's., and M.Sc's., is slightly in excess of the posts requiring these qualifications but the surplus is almost entirely absorbed in posts requiring lesser qualifications. But as an unduly large proportion of graduates study law, the incidence of unemployment is shifted from the category of graduates to that of lawyers.

Among the causes are mentioned, the increasing pressure of population on the soil, the importation of machine made goods to the countryside which is driving out the village artisan from his hereditary occupation, the drift of population towards the town, and the fall in the price of the agricultural produce which has indirectly hit the lawyers, doctors and traders.

As far as the Government and the quasi-Government services are concerned, Biharis are very poorly represented in the all-India services for which special coaching arrangements should be made by the University and the local Government. Recruitment to all provincial and subordinate services should be by competition as far as possible. All Government officers should be compelled to retire at 55. The diploma of the Bihar College of Engineering should be recognized and a representation should be made by the local Government to the Railway Board to exclude all outsiders (non-Biharis) from the vacancies in Bihar.

Among the medical graduates about 30% are under-employed or unemployed. Doctors should be encouraged to set up country practice and the system of subsidizing country doctors should be extended. There is a great deal of unemployment among the lawyers of whom only about 20% earn a decent living. The number of law graduates should be restricted in future. There is some scope in insurance and journalism. The committee is of opinion that there is not much possibility in Bihar of diverting young men in towns to agriculture for a variety of reasons. The scope of any colonization scheme is also very limited. However to prevent the flow of village population to towns, village life should be made more attractive for which rural reconstruction schemes should be carried on more extensively throughout the province.

There can be no lasting solution of the unemployment problem without industrial development, but this requires the co-ordinated effort of the local Government and the Government of India, as vital factors *e.g.* currency, tariff, railway freight etc. are in the hands of the latter. Government should also obtain expert opinion regarding the possibility of supplying cheap electricity all over the countryside by means of a grid system with generating stations conveniently located. The committee has made a rough survey of the employment afforded in large industries, and have found that there are more than 45,000 posts carrying a pay of Rs. 20/- or more in the large industries of Bihar and Orissa. Out of about 17,218 posts in the Tata Steel Works about 88% are held by Biharis and Ariyas. The copper industry of Singhbhum has 715 posts of Rs. 20/- on over of which local men hold about 27%. Out of 8,600 similar posts in the Jharia coal mines about 40% are held by local men. The corresponding figures for sugar industry are 3,655 and 66%. Efforts should be made to increase the employment of Biharis in these industries. For better employment of civil engineers, the local Government should lay down that for all works under the Government and local bodies above a certain figure, preference should be given, other things being equal, to those contractors who are themselves qualified engineers or who undertake to employ qualified men.

The committee in conclusion suggests that some selected educationist should be trained in Europe in industrial psychology and should be attached to the staff of the director of public instruction to advise parents and headmasters on the suitability of careers for boys of school-leaving age.

For developing the large industries, Government should themselves start demonstration factories with experts. State aid should be granted liberally to finance educated young men in setting up cottage or small industries. The interest on loans for these purposes should be as low as possible. Appropriate action should be taken by Government to protect nascent industries from unfair competition. An unemployment census is not recommended but the educational and technical institutions should maintain detailed occupation registers of their passed students and submit annual reports from which the Information Bureau should compile an annual statement for the information of the Government and the public.

Mr S. P. Mookerjee on University Ideals

In his Convocation Address to the Nagpur University on November 5 last, Mr Syamaprasad Mookerjee beautifully summed up what the ideals of an Indian University should be. "Generally speaking", said he, "the Indian university must regard itself as one of the living organs of national reconstruction. It must discover the best means of blending together both the spiritual and the material aspects of life. It must equip its alumni irrespective of caste, creed, or sex, with individual fitness, not for its own sake, not merely for adorning varied occupations and professions, but in order to teach them how to merge their individuality in the common cause of advancing the progress and prosperity of their motherland and upholding the highest traditions of human civilization."

"A university", continued Mr Mookerjee, "is not worth its name which does not provide for both teaching and research of the highest order in diverse branches of knowledge. India must produce her own band of discoverers and conquerers of new realms of thought who will help to raise the intellectual level of the country and call forth this spontaneous homage and respect of nations far and wide.

"It will be for them to devise ways and means for conserving and utilizing the rich and inexaustible raw materials in which this country abounds, not for individual profitering but for the benefit of its toiling millions and for providing them with food, clothing and shelter, thus stabilizing national efficiency and wealth and preventing their continued exploitation.

" Problems of health, sanitation, hygiene and diet will be investigated and the conditions for the alleviation of suffering and malnutrition carefully analysed. Agriculture must form a distinctive part of the work of the university and the possibility of increasing the productive power of land with the aid of science explored and explained.

" Neither will cultural pursuits and the study and investigation of arts and letters be discontinued or discouraged. Philosophy, literature, archaeology and architecture, fine arts including music and painting, the Indian languages, classical and modern history and polity will be carefully nurtured and the correct interpretation of the manifestations of the genius of India in the realm of thought and culture will be faithfully and courageously given."

In conclusion Mr Mookerjee enumerated the needs of the hour of the university education in India and stressed the necessity of State aid in this connection.

"A system of education, consistent with the genius of the people of India and suited to modern life and conditions, cannot be fully achieved unless and until India enjoys a political status which will give her the liberty to decide for herself what constitute her national needs and how best they can be satisfied. Secondly, there must be less of degrading poverty and less of disease and pestilence, now nation-wide in extent, which are sapping our vitality and energy and shutting out the inrush of joy, light and beauty into this land of proud and ancient civilization. Thirdly, the State must spend far more adequately and generously on education, in all its grades, than it has done in the past. All schemes for reconstruction will remain unrealized until this paramount condition is whole-heartedly fulfilled. Fourthly, there must be an elaborate system of elementary and secondary education which will form an enduring foundation on which the great structure of university education will be built. Fifthly, education at every stage should be as cheap as possible while its quality will be maintained at a high level. Sixthly, while expressing our deepest gratitude to our past benefactors, let us emphasize that the universities must inspire private benefactions on a much wider scale than they have hitherto done. Seventhly, there must be a close and honourable connexion between education and trade, industry and commerce, so that men trained in different branches of practical skill and knowledge will have a natural scope for their talents. Mere technical education, divorced from such association, can never solve the problem of unemployment. Lastly, the universities must be given the amplest freedom to work out their salvation. We must free education from the under-currents of political and communal strife."

Research Notes

A New Essential Dietary Factor

It was found by Elvehjem and coworkers that flavins are inactive in the cure or prevention of pellagra-like symptoms in the chick and black tongue in dogs, and that a fraction prepared from liver extract from which the flavin had been removed by adsorption on Fuller's earth was highly active in the prevention of both these syndromes. Dann (*J. Nutrition, 11*, 451, 1936) also reported that pellagrins do not respond to lactoflavin but to liver extract.

Birch, György and Harris also found that the human pellagra-preventing factor is different both from vitamin B_6 and from lactoflavin, two known components of the vitamin B_2 complex.

It is therefore evident that flavins are not the human pellagra-preventive factor.

Elvehjem, koehn and Oleson (*J. Biol. Chem, 115*, 707, 1936) now report the presence of another essential dietary factor present in the alcohol-ether precipitate obtained from the liver extract during the separation of the flavin and vitamin B_2 from it.

Using rats for assaying the potency of the factor and devising a complete ration as synthetic as possible and supplying ample amounts of vitamin B_1, B_2, B_4, B_6 and flavins, there was lack of growth and general emaciation. Thus their ration was deficient in an additional unrecognized factor.

When the alcohol-ether precipitate equivalent to 2% liver extract was added to the basal ration phenomenal growth response was observed. The factor in found to be quite heat-labile, being completely inactivated by autoclaving at 120° for 6 hours at 15 pounds pressure.

The factor occurs in liver, yeast, and milk and is water soluble. It is insoluble in the fat solvents and can be adsorbed on charcoal.

H. N. B.

On Three-fold Magneto-ionic Splitting

Appleton, Hartree, Goldestein, and others have shown that an ionized medium under the influence of a magnetic field becomes doubly refracting. It can be easily shown that a radio wave travelling upwards can be reflected from three different places having different concentrations of electrons. Usually only two echoes due to reflections from the two lower-most concentrations have been observed, but Toshniwal and coworkers, working at Allahabad, have on several occasions (*Proc. Nat. Inst. Sc. India, 1*, 87, 1935) observed three echoes, and for the first time towards the end of December 1935, Toshniwal has explained (*Nature, 135*, 437, 1935) these echoes as due to three-fold magneto-ionic splitting as demanded by the theory.

This explanation was lacking verification from virtual-height-frequency curves which always showed only two critical frequencies whereas, in view of the above explanation, there should be three such frequencies. Recently, however, Leiv Hkrang (*Terr. Mag., 41*, 160, 1936) working at the University of Troms in Norway has confirmed Toshniwal's observations and predictions. He has procured excellent virtual-height-frequency curves showing three critical frequencies. The frequency differences between these penetration frequencies are in excellent quantitative agreement with those expected from theory.

R. R. Bajpai.

The Preservation of the Australian Aborigines

In a leading article in the *Illustrated London News* of October 24, 1936, Mr W. E. H. Stanner, on behalf of the Australian National Research Council, has discussed some interesting results of his anthropological expedition among the northern Australian aborigines and has testified to the soundness of the new policy of the Australian

Government regarding the preservation of the aborigines. The aborigines in Australia have at present dwindled from 250,000 to 76,000 and the new measures contemplated by the Government would divide them into three groups:

1. Detribalized natives, such as those living near Darwin and other northern towns.

2. Tribes near pastoral settlements and other white stations.

3. Myalls beyond civilized control.

Regarding the first group the Government has planned to educate them after white standards. The Darwin areas will be under a reserve with barracks and schools, and other recreational and sanitary facilities will also be arranged for. These people, hitherto, had been exploiting the domestic animals and the natural products of the soil as their sources of food, and it is hoped now that this will help in growing in them a community sense centred in family homes. The second group will be placed under reserves but their native mode of living will not be tampered with while the last group will continue to live absolutely in their present state.

The depopulation of the aborigines of India has been going on for a long time, and the extreme urgency of adopting protective measures, has been urged by all who have a first hand knowledge of the aborigines of India, such as, Drs. Hutton, Guha, Mills, etc. but unfortunately no rational policy has yet been adopted by the Government. It is essential that steps are taken immediately before some of them, such as, the Andamanese, or the Todas, share the same fate as that of the Tasmanians who have become completely extinct now.

S. S. Sarkar.

The Discovery of Bronze

In *Scientia, 60,* October 1936, Professor J. R. Partington considers some interesting problems concerning the origin of bronze. The earliest specimens of the metal contain a very small amount of tin, but with a more abundant supply of tin and greater experience, the amount became standardized at 10 p.c. of tin and 90 p.c. of copper in all bronze-producing countries. Philologically the Egyptians and Sumerians, unlike the Jews, Greeks and Romans, distinguished between copper and bronze. Tin bronze was first used in Mesopotamia in the early Sumerian period, although a doubtful specimen has been reported from the First Dynasty in Egypt, where its use in B.C. 3000 is sporadic and small. Afterwards it became scarce, being replaced by inferior alloys of copper with lead and antimony. Tin bronze again reappears in Babylonia and Assyria about B.C. 1700-1500, by which time it was also common in Egypt. It is a mistake to suppose that the Sumerian culture passed through a copper age and entered a bronze age later than Egypt. In Crete and Cyprus bronze was in vogue from B.C. 2400-2200.

In Egypt copper was obtained from the peninsula of Sinai and, later on, from Cyprus and elsewhere, while the earliest Sumerian copper is supposed to have come from Oman. It has been repeatedly suggested that Cornwall tin was imported by Egypt and Babylonia, but this is highly improbable, as British tin did not appear in the Middle East before B.C. 1000, or, at the earliest, B.C. 1700-1500. It is altogether uncertain whether the tin of interior Africa was used in Egypt. A probable source is Khorassan; it is interesting to recall that according to Strabo Drangiana was a tin-producing country. This region may have also supplied tin to the settlers of Mohenjo-daro, where very good tin bronze, similar to the early Sumerian bronze, has been unearthed. It is an interesting speculation, though no archaeological evidence is as yet forthcoming, that it was round about Drangiana that bronze was first made about B.C. 3500 and its use diffused thence to Mesopotamia and India.

A. Ghosh.

Ancient India in Indo-China

Dr H. G. Quaritch Wales, Field Director of the Greater-Indian Research Committee, describes the results of his investigations in Siam in *Discovery, 17,* November 1936. He began with Takuapa on the west coast of peninsular Siam, possessing a natural harbour and usually identified with the Tokola Mart of Ptolemy. On one of the islands forming the harbour, ancient pottery is strewn all over, a study of which shows that the settlement flourished from about the 4th to the 8th or 9th century A. D., and though primarily Indian, it was frequented by Chinese and Arab merchants. The mounds of the area revealed a temple after excavation. Twelve miles up the Takuapa river some images, one of which is that of Siva, are found; they are of South Indian workmanship and belong to the 7th or 8th century A. D. It is suspected that they were removed there from the original Takuapa temple.

Exploration proceeded eastward across the Peninsula. In the City of the Lake ancient Indian images of great interest are found. Epigraphical evidence shows that Chaiya, north of the Bay of Bandon, was the capital of a great Indianized empire, extending over the Malay Peninsula and the islands of Java and Sumatra from the 8th to the 12th century.

These investigations along the overland route show the existence of a belt of ancient Indian remains stretching across the Peninsula, but exhibiting an evolution from purely Indian sculptural and architectural forms on the west coast to more local colonial types at the sites of great cities near the east coast. It is evident that between the 4th and 8th centuries several waves of Indian colonists, each bringing the Indian art and religion of the period, spread across the Peninsula by this route, in order to avoid the pirate-ridden waters of the Straits of Malacca.

The ruins of an ancient city, locally known as Srideva, in the remote Pasak valley of eastern Central Siam, were examined. Though all traces of palaces and dwellings have disappeared, as they were built of wood, it is evident that the town was Indian in plan. There is still an Indian brick temple with a simple brick tower, resembling the temple at Bhitargaon (Cawnpore district), which has been ascribed to the 5th or 6th century. It is thus the earliest Hindu temple in Indo-China. Many fine sculptures are also found here, mostly representing Vishnu and belonging to the Gupta period. A Sanskrit inscription, written in 6th century Deccan characters, was also found among them. The city was re-occupied by the Khmers in the 11th century, but their activities did little harm to obscure the Indian aspect of the city.

A. Ghosh.

Tests of Validity of the X-ray Crystal Method of Determining e

The absolute measurement of X-ray wavelengths with ruled gratings by Bäcklin and others has led to a fresh determination of the electronic charge. The final average value of e obtained by this method is 4.805×10^{-10} e.s.u. It is distinctly divergent from the so-called oil-drop value, known after the famous experiment of Millikan, which gives $e = 4.769 \times 10^{-10}$ e.s.u. The difference between the two is about 7 in 1000 and is beyond the limits of total probable error allowed by either set of experiments. Further, their ratio yields very nearly the celebrated fraction 136/137, which has been regarded as possibly significant by physicists.

The situation has, however, changed considerably since the above remark of the theoretical physicists. Both the methods of determining e have been criticized as regards their weak points. They are *viz.* (*i*) in the oil-drop experiment the value of η the coefficient of viscosity of air, used by Millikan requires to be verified, being rather too few; (*ii*) in the X-ray method the determination of the lattice constant by diffraction of X-rays assumes that the density of the crystal is same everywhere *viz.*, at the surface, where Bragg reflection takes place (the penetration in the first order is about 5×10^{-4} cm.). The recent experimental investigators have taken into account these criticisms and have attained almost the same value of e by the two revised methods, which are given below.

Kellström [1] has undertaken a series of careful experiments to determine η with an apparatus improved so as to ensure the constancy of temperature and speed of rotation of the cylinder. His latest value of η is 1834.9×10^{-7} and this fitted into the other data of Millikan gives $e = 4.818 \times 10^{-10}$ e.s.u.

in better agreement with the X-ray value. Later, Bäcklin and Flemberg[2] have repeated the oil-drop experiment with an improvod apparatus and have obtained $e = 4.800 \times 10^{-10}$ e.s.u. with Kellström's value of the coeficient of viscocity of air.

The X-ray experiment has been performed in a novel way by DuMond and Bollman[3] with finely powdered crystals. They used grains of calcite crystal of size 2×10^{-4} cm. and less, which were less than half the thickness required to extinguish the X-ray *viz.*, 4×10^{-4} cm. (measured). With a Seeman-Bohlin spectrograph the grating constants of the crystal grain were determined precisely for the three different sets of Miller indices. The density of the same sample of crystal powder was measured very accurately with a pycnometer. This was in excellent agreement with the so-called macrosocpic density. Assuming for Cu Kα, $\lambda = 1.5406 \times 10^{-8}$ c.m. (Bearden's value with ruled grating) the value of the electronic charge e is found to be $(4.799 \pm \cdot 007) \times 10^{-10}$ e.s.u. The close agreement of this value with the revised oil-drop value as well as with the previous X-ray value establishes the validity of the latter method and also shows that defects in the interior of the crystal, if present at all, are practically negligible.

P. C. Mukherjee.

1. G. Kellström *Phys. Rev.* *50*, 190, 1936.
   Nature *136*, 612, 1935.
2. Bäcklin & Flemberg *Nature* *137*, 655, 1936.
3. DuMond and Bollman *Phys. Rev.* *50*, 383, 1936.
   „ *50*, 524, 1936.

University and Academy News

Royal Asiatic Society of Bengal

An ordinary monthly meeting of the Royal Asiatic Society of Bengal was held on Monday, the 2nd November, 1936.

The following candidate was elected an Ordinary Member.

Bothra, Subhkaran, B. A., Landholder and Student; 3, Vivekananda Road, Calcutta.

The following paper was read :

PADMANATH BHATTACHARYYA.—*Location of the Land granted by the Nidhanpur Grand of Bhāskara-varman of Kāmarupa.*

This article is a rejoinder to a paper with the same title that was published in the Society's Journal in last April by Dr N. K. Bhattasali, in which the writer had concluded that the location of the land granted by Bhāskara-varman was in Sylhet. In the paper the author has endeavoured to prove that the location of the land related to a place in Rangpur and not in Sylhet.

Calcutta Mathematical Society

An ordinary meeting of the Calcutta Mathematical Society was held in the Society's room, on Sunday, the 29th November, 1936, at 4-30 p.m.

The following papers were read :

1. R. C. Bose: Theory of skew rectangular pentagons in Hyperbolic Space, Part II.
2. M. de Duffahel (Stamboul): Sur l'Equation aux derivees partielles qui se presente dans la theorie de la propagation de l'Electricite.
3. M. de Duffahel (Stamboul) : Sur les couples de Fonctions uniformes d'une variable.
4. B. B. Sen : Note on the transverse vibration of freely supported plates under the action of moving loads and variable forces.
5. R. S. Varma : An infinite integral involving Bessel function and parabolic cylinder function.
6. N. Rama Rao and Basava Raju : An extension of Wilson's theorem.
7. S. P. Slonguinoff (Perm, U. S. S. R.): Equation de Laplace dans l'espace à deuse dimensions.
8. Olga Taussky (Cambridge): Rings with non-commutative addition.
9. S. Ghosh : On the solution of Laplace's equation suitable for problems relating to two spheres touching each other.
10. S. Ghosh : Stress distribution in a heavy circular disc held with its plane vertical by a peg at the centre.

The National Academy of Sciences, India

The ordinary monthly meeting of the National Academy of Sciences, India, was held in the Physics Lecture Theatre, Muir College Buildings, Allahabad, on the 8th October, 1936. Prof. N. R. Dhar, President of the National Academy was, in the chair.

The following papers were read and discussed :—

1. N. R. Dhar and S. K. Mukerji, (Allahabad): Alkali Soils and their reclamation. Part II.
2. N. R. Dhar and S. K. Mukerji, Allahabad: Nitrogen fixation in soils by Cellulosic materials, Oils, Fats, etc. Part I.
3. Radha Raman Agarwal and S. Dutta, Allahabad : The Chemical Examination of Terminalae Arjuna Bedd; Part I. Isolation of Arjunalin from the alcoholic extract.
4. Satyendra Ray, (Lucknow): On the Statistical Interpretation of Entropy : A Criticism of Nernst.
5. B. N. Singh and M.V. Saradhy, (Benares): Superposed Parasitism of Cuscuta Reflexa. Roxb.
6. B.N. Singh and P. B. Mathur, (Benares): Respiratory Response of Ripe Tomatoes and Dormant Potatoes following wounding.

At the above meeting Prof. Dhar gave an account of his researches along with pupils, Messrs S. K. Mukerji, E. V. Seshacharyulu and N. N. Biswas on the reclamation of alkali soils using different oil cakes and press mud.

Oil cakes, which are available all over the country even in rural areas, containing 4-5% nitrogen, oils, cellulosic substances, etc., readily neutralize the alkali of Usar (alkali) soils. Moreover, as there is plenty of nitrogen in all oil cakes, the nitrogen deficiency and other defects of alkali soil are remedied by the addition of oil cakes. 10-20 maunds of oil cakes per acre have been found to be effective in reclaiming alkali land and made suitable for the growth of rice.

Press mud, which is a solid substance containing calcium salts, carbohydrates, and nitrogenous matter and is available to the extent of about 400,000 tons from the Indian sugar factories, has been found to be an excellent reclaiming agent for even bad alkali soils. Mixtures of press mud and molasses are also very effective. The Professor stated that using one ton of molasses per acre, the Mysore Government obtained 1200-1800 lbs of rice grains per acre, where the crop failed previously. The normal production of rice in India is 1295 lbs per acre. Alkali land has also been reclaimed at Soraon (Allahabad), Shahjahanpur, Unao, Cawnpore and in Behar, using molasses at the rate of 3-10 tons per acre of alkali soil.

Letters to the Editor

The *Magneto-Ionic Formula*

I have read with interest the communication of Dr Toshniwal[1] on Absorption in the Ionosphere in which he describes results of his theoretical calculations and also of observations and maintains that the relative absorptions of the extraordinary and ordinary rays are just the reverse of the usually accepted values. I had the privilege of reading the analysis of Dr Toshniwal and also of discussing the matter with him and I gathered that he thinks that the origin of the discrepancy lies in our interpretation of the ordinary and the extraordinary rays. I quite agree with him in this and, as will be seen from the analysis of Mr J. N. Bhar given below, the discrepancy disappears if care is taken to correctly associate the signs—positive or negative beforethe radical in the Appleton-Hartree formula—with the extraordinary or the ordinary ray. It will also be seen that with this form of the magneto-ionic equation as used by Dr Toshniwal it is not permissible to associate one particular sign before the radical with either the extraordinay or the ordinary ray for all conditions of propagation. This is possible only when the formula is suitably modified to fulfil certain condition.

I would in this connection make a remark regarding the use of the terms ***ordinary*** and ***extraordinary***. The origin of the use of these terms lies in the fact that the condition of reflection of one of the rays (ordinary) is not affected by the magnetic field while that of the other (extraordinary) is strongly affected by such a field. But unfortunately this terminology is not always applicable. In the quasi-longitudinal case, for example, the conditions of reflection of both the rays are equally affected by the magnetic field and logically both should be called extraordinary rays.

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S. K. Mitra.

I

Dr Toshniwal[1] starts with the original Appleton-Hartree equation

$$M^2 = \left(\mu - \frac{ick}{p}\right)^2$$

$$= 1 + \frac{1}{a + i\beta - \dfrac{\gamma_T{}^2}{2(1+a+i\beta)} \pm \sqrt{\dfrac{\gamma_T{}^4}{4(1+a+i\beta)^2} + \gamma_L{}^2}} \qquad \ldots \qquad \ldots(1)$$

and states that by following a method of analysis similar to that of Booker[2] he has obtained a ratio of the integrated absorption coefficients of the ordinary and extraordinary rays which is different from that of Booker. Following Booker Toshniwal has proceeded on with equation (1) by putting it in the form

$$M^2 = 1 + \frac{1}{X + iY} \quad \ldots\ldots\ldots\ldots\ldots(2)$$

Now, if $\beta << a$, then the expressions for X and Y are as follows :

$$X = a - \frac{\gamma_T{}^2}{2(1+a)} \pm \sqrt{\frac{\gamma_T{}^4}{4(1+a)^2} + \gamma_L{}^2} \quad \ldots.(3a)$$

$$Y = \beta\left[1 + \frac{\gamma_T{}^2}{2(1+a)^2} \mp \frac{\gamma_T{}^4}{2(1+a)^2\sqrt{\gamma_T{}^4 + 4\gamma_L{}^2(1+a)^2}}\right] \quad \ldots.(3b)$$

Remembering that $X >> Y$ or ($\beta << a$), the condition for reflection, *i.e.*,

$$M^2 \doteqdot 0, \text{ is given by } X \doteqdot -1, \text{ or}$$

$$1 + a - \frac{\gamma_T{}^2}{2(1+a)} \pm \sqrt{\frac{\gamma_T{}^4}{4(1+a)^2} + \gamma_L{}^2} = 0 \quad \ldots.(4)$$

The source of ambiguity lies in the interpretation of this equation as to which of the signs before the radical will give us the ordinary and which the extraordinary ray. Toshniwal thinks that the positive sign gives us the ordinary ray since, according to him, its reflection condition

is given by $1+\alpha=0$ and the negative sign the extraordinary ray since its reflection condition is given by $1+\alpha=\pm\gamma$. This, however, is not always true particularly when we consider reflection from the region from which the radio waves are usually returned, *viz.*, where $1+\alpha$ is negative.

Let us now consider the conditions of reflection from this region ($1+\alpha$ negative or $N<\frac{mp^2}{4\pi e^2}$). These are

$1+\alpha=-\gamma$, (positive sign before the radical)

and $1+\alpha=0$, (negative sign before the radical).

If, however, we consider the region where $1+\alpha$ is positive, *i. e.*, $N>\frac{mp^2}{4\pi e^2}$, then the condition for reflection is

$1+\alpha=0$, (positive sign)

and $1+\alpha=+\gamma$, (negative sign).

The above statements may seem contradictory and ambiguous but their import will be clear from the dispersion curves in Fig 1, which have been drawn for the so-called quasi-transverse case, *i. e.*, $\gamma_T{}^4/4(1+\alpha)^2>>\gamma_L{}^2$. The friction term has been neglected ($\mu^2=1+1/X$), and the wave frequency is greater than the gyromagnetic frequency. In the diagram μ^2 is plotted against x which is proportional to N ($x=-\frac{1}{\alpha}=\frac{4\pi Ne^2}{mp^2}$; p constant).

The curves are self explanatory, the *plus* and the *minus* signs indicating that to obt in the respective portions of the curves the positive and the negative sign before the radical have been used. The curious jumps which occur whenever the curves cross the line $-\frac{1}{\alpha}=x=1$ can be understood if we remember that on the left of the point O, $1+\alpha$ is negative and on the right of O it is positive. In carrying out the computations it must further be remembered that the expression under the radical has to be first evaluated by assigning the proper numerical values to the terms α, γ_L and γ_T and the square root of same extracted afterwards; the positive and negative signs before the radical give the two possible values of the root.

Fig. 1, as pointed out before, is for the quasi-transverse case. To study the transition from the quasi-transverse to the quasi-longitudinal case we examine Fig. 2. As the direction of propagation approaches more and more the direction of the magnetic field all the three curves change their shapes and in the limit join up to form the two single lines AE_1 and AE_2. At the same time the asymptote DC of Fig. 1 gradually shifts towards the line OF and in the limit coincides with it. The line AME_2 (*Fig. 2*) which consists really of a portion of AMO and a portion of FME_2 is throughout given by the negative sign while the line AE_1 straightens out and is given by the positive sign.

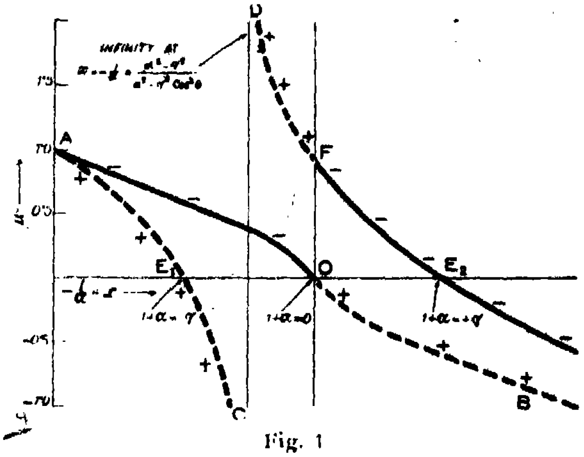

Fig. 1

Now, it is customary to designate the two components into which a wave is split up on entering the ionosphere as ordinary and extraordinary. The ray, the condition of reflection of which is unaffected by the magnetic field, is called the ordinary and the one affected by the magnetic field is called the extraordinary. According to this definition the ray reflected from the point O (Fig. 1) is ordinary and that from the points E_1 and E_2 is extraordinary. If, however, we confine our attention to the region in which N varies from 0 to $\frac{mp^2}{4\pi e^2}$ we might say that the ray given by the negative sign before the radical is the ordinary and that given by the positive sign the extraordinary. In the region where $N>\frac{mp^2}{4\pi e^2}$ the reverse is the case. Since, however, in the longitudinal case the whole of the curve AE_2 is obtained by using the negative sign and its earlier portion ($N<\frac{mp^2}{4\pi e^2}$) corresponds to the ordinary in the general case, we may call the ray reflected from E_2 in the longitudinal case as ordinary. This, however, is not justifiable if we recall the definition that the ordinary ray is the one the reflection condition of which is unaffected by the magnetic field. It must be borne in mind that in the quasi-transverse case the most important portions of the curves are those lying on the left of OF where $1+\alpha$ is negative. It is from this region that rays are usually reflected.

Toshniwal, in carrying out his calculations, has presumably failed to take this into account and has called the ray corresponding to the positive sign before the radical as ordina y and that given by the negative sign as ex raordinary. He has pushed this convention regarding the signs still further and even when dealing with the quasi-longitudinal case calls the ray corresponding to the negative sign as extraordinary; this is in contradiction with the current nomenclature. If this reversal of sign is taken into account the whole of the discrepancy between his and Booker's absorption formulae disappears.

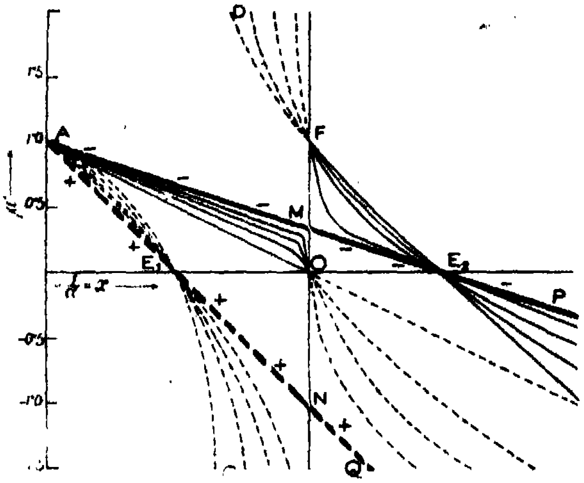

Fig. 2

II

It is perhaps worthwhile to consider in a little more detail the points regarding the correct use of the signs referred to above. Let us neglect friction and write equation (1) in the following form:

$$\left[\frac{1}{\mu^2-1} - \alpha\right] = \frac{-\frac{\gamma_T^2}{1+\alpha} \pm \sqrt{\frac{\gamma_T^4}{(1+\alpha)^2} + 4\gamma_L^2}}{2} \quad \ldots\ldots\ldots(5)$$

Consider the changes in its left hand member when $1 + \alpha$ in the right hand side passes through zero value. α remains very nearly equal to -1 during this change and we can write equation (5) in the form

$$D = \frac{-\frac{b}{m} \pm \sqrt{\frac{b^2}{m^2} + 4c}}{2} \quad \ldots\ldots\ldots(5a)$$

The two values of D obviously satisfy the quadratic equation

$$D^2 + \frac{b}{m}D - c = 0 \quad \ldots\ldots\ldots(5b)$$

$\left[D = \frac{1}{\mu^2-1} + 1;\ b = \gamma_T^2;\ m = 1+\alpha;\ c = \gamma_L^2;\ \gamma_L\right.$ and γ_T may be considered as stationary for the range of values considered since α remains nearly equal to -1].

Now, taking the lower negative sign in equation (5a), we find that if m is small and negative and approaches zero $\left(\frac{b^2}{m^2} >> 4c\right)$ then the two terms on the right hand side are of nearly equal magnitude; they nearly cancel out each other and D has a very small negative value. This is the condition for points situated close to and on the left of the point O (Fig. 1). If, however, m is small and positive and approaches zero $\left(\frac{b^2}{m^2} \text{ is again } >> 4c\right)$ the two terms on the right hand side have the same sign (−ve) and they add up; D has now a very large negative value and approaches ∞ as m approaches zero. This is the condition for points situated close to and on the right of O (Fig. 1).

Similar considerations taking the upper positive sign before the radical explain the discontinuity at O, *i. e.* when $1+\alpha = 0$.

If we want to preserve continuity in the curves then, when we pass through zero value of m ($= 1+\alpha$) from negative to positive or positive to negative, we must at the same time change the sign before the radical—positive to negative or negative to positive—as the case may be. This is really what ought to be done, because, when the coefficient of D in equation (5b) is negative it should be written in the form

$$D^2 - \frac{b}{m}D - c = 0,$$

the roots of which are

$$D = \frac{\frac{b}{m} \mp \sqrt{\frac{b^2}{m^2} + 4c}}{2} \quad \ldots\ldots\ldots(5c)$$

the positive sign before the radical in equation (5a) corresponding to the negative sign in equation (5c) and vice versa. The necessity of reversing the signs to maintain continuity has also been mentioned by Booker, *loc. cit.* page 275. This ambiguity and source of confusion regarding the correct use of signs may be avoided if we remove from the coefficient of D the factor $\frac{1}{m} = \frac{1}{1+\alpha}$ which is changing in sign. Thus if we write equation (5b) in the form

$$mD^2 + b\,D - mc = 0, \quad \ldots\ldots\ldots(5d)$$

then the values of D are given by

$$D = \frac{-b \pm \sqrt{b^2 + 4m^2c}}{2m}$$

If now α changes from a small negative to a small positive value and passes through zero, the value of D for either the positive or the negative sign before the radical does not change discontinuously. This is what has been done by Ratcliffe[3] in his paper on "The Magneto-Ionic Theory."

Ratcliffe has written the magneto-ionic equation in the form

$$\mu^2 = 1 - \frac{2x(1-x)}{2(1-x) - y_T^2 \mp \sqrt{y_T^4 + 4y_L^2(1-x)^2}} \quad \ldots (6)$$

where $x = -\frac{1}{a}$; $y_{T,L} = -\frac{1}{a}\gamma_{T,L}$. The upper and lower signs—negative and positive—in this equation correspond to the upper and lower signs—positive and negative—in equation (1). If μ^2 is now plotted against x, the whole of the curve AOB is given by the lower positive sign while the two branches AE_1C and DFE_2 are given by the upper negative sign (Fig. 1). A difficulty, however, may be experienced when considering the transition into the longitudinal case when, unlike the results obtained from equation (1), the whole of the line AME_2 is not obtained throughout by using the same sign (+ve) in equation (6); the portion AM is given by the positive sign while the portion ME_2 is given by the negative sign. The line AE_2 thus consists partly of ordinary (AM) and partly of extraordinary (ME_2) of the dispersion curves. The rays reflected from the points E_1 and E_2 should thus both be strictly called extraordinary rays, firstly because they both belong to the extraordinary branches of the dispersion curves and secondly because their reflection conditions ae both affected—and similarly so—by the magnetic field.

The fact that neither of the lines AMP and ANQ in the longitudinal case is throughout given by one sign is often lost sight of when we write their equations in the usual form

$$\mu^2 = 1 - \frac{x}{1 \mp y} \quad \ldots\ldots\ldots\ldots\ldots (7)$$

This form is not, however, strictly correct, if we consider its derivation from equation (6). For the longitudinal case equation (6) takes the form

$$\mu^2 = 1 - \frac{2x(1-x)}{2(1-x) \mp |\,2y_L(1-x)\,|} \quad \ldots\ldots (8)$$

We obtain equation (7) from this if we cancel out $1-x$ in the numerator and denominator. This cancellation, however, is not justifiable because in the term $2y_L(1-x)$ only the magnitude of the factor $(1-x)$ is involved. Ratcliffe, in his paper mentioned above, has ommitted to note this and in his equation on page 356 for the longitudinal case, which is same as equation (8), does not signify that only the magnitude of $2y_L(1-x)$ is to be taken. Equation (7) as such is nevertheless obtained if we proceed after Lorentz to consider propagation of wave in the direction of the magnetic field. The interpretation of this is obtained if we take into account the changes in the polarization of the waves as we cross the line $x = 1$. (See the paper of Ratcliffe referred to above, p. 359).

III

Toshniwal has not put the correct interpretation on his results as, in my opinion, his use of signs in equation (1) is not justified. It readily follows from *his* convention of the signs that the ray he calls extraordinary should be reflected from a higher level of the ionosphere, *i.e.*, in stratification splitting the extraordinary ray should be more delayed. This is just the reverse of what is usually observed. Again, according to *his* observations, the extraordinary ray which, according to *his* use of signs, should be the longer delayed component, is stronger than ordinary ray. This is what is usually observed, only the longer delayed component is called the ordinary instead of extraordinary.

In support of his observations Toshniwal quotes Eckersley's results. Eckersley, however, in a subsequent note[4] states that there was an accidental reversal of sign which was the cause of the disagreement with results obtained according to the magneto-ionic theory.

Toshniwal further states that "it can be easily shown from equation (1) that in an ionized medium the group velocity of the extraordinary ray is less than that of the ordinary ray." The statement as far as the relative group velocities of the two rays are concerned is quite correct, but this cannot be shown from *his* use of signs, viz., the positive sign for the ordinary and the negative for the extraordinary in equation (1).

His observations on relative absorptions in group-retardation splitting during day time presumably agree with those usually observed. Since, however, this apparently contradicts his deductions from the wrong use of the signs he has attempted to explain the results by assuming that the range of integration of the absorption of the extraordinary ray which, according to him, should begin from the level $\nu = p + p_L$ is greater than that of the ordinary ray. By the correct use of the sign, however, the level of maximum absorption of the extraordinary ray comes out to be that given by $\nu = p - p_L$. The assumption of greater range of integration therefore does not hold.

We hope to deal more fully in another paper the above points regarding the magneto-ionic formula taking account of the frictional term.

I would take this opportunity of thanking Prof. S. K. Mitra and Dr. H. Rakshit for discussion and for helpful interest in the work.

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1. Toshniwal, SCIENCE & CULTURE, *2*, 277, 1936.
2. Booker, *Proc. Roy. Soc. A 150*, 267, 1935.
3. Ratcliffe, *Wirl. Eng.* and *Expt. Wirl. 10*, 354, 1933.
4. Eckersley, *Nature*, *131*, 312, 1933.

On the Crystalline Constituents of *Seseli indicum*.

From the fruits of *Seseli indicum* we have been able to isolate two colourless crystalline substances. One of these, which melts at 117—8°, is obtained in a yield of 1·3%. It has the molecular formula $C_{14}H_{12}O_3$. It contains no —OH or $—OCH_3$ groups, and behaves like a neutral unsaturated lactone. The second substance, obtained in a yield of 0·6%, melts at 183-4°. Analytical data agree with the formula $C_{11}H_5O_3(OCH_3)$. It is probably a furocoumarin isomeric with bergapten. Further experiments to elucidate the constitution of the compounds are in progress.

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A Note on the Peristaltic Movements of the Alimentary Canal of *Paratelphusa (Oxiotelphusa) Hydrodromus* (Herbst)

The passage of food in the mid-gut and the hind-gut is mainly brought about by the peristaltic movements of these regions. These movements are very feeble in the case of the mid-gut. Each peristaltic wave requires 1.5 to 2 minutes for its completion. In he hind-gut these are very pronounced. 4 to 6 wav s per minute are produced in this case. As in the case of *Nephrops* (Yonge 1924)[1] each peristaltic wave starts in the anterior region of the hind-gut, quite independent of those of the mid-gut, and proceeds posteriorly towards the anus. With every wave the anus is extended. It has been pointed out by Yonge (1924)[1] that this pronounced and independent peristalsis of the hind-gut is due to the presence of the layer of inner longitudinal muscles in its walls.

Peristalsis of the mid-gut and hind-gut is partly regulated by an elaborate nerve plexus which has been extensively investigated by Miller[2] (1910) and Alexandrowicz (1909)[3] in the case of the crayfish and the lobster. Electrical excitation of the last abdominal ganglion brings about an increased tone accompanied by an increase in the normal peristaltic rhythm. These movements continue even after the removal of the last abdominal ganglion. As in Nephrops (Yong 1924)[1] the peristalsis is not entirely dependent on the central nervous system.

The author is not aware of any studies relating to the effect of any internal secretion on the peristaltic rhythm in any decapod crustacean[4]. Perfusion of the isolated mid-gut and hind-gut by adrenaline with epinine brings about a remarkable increase in the normal peristaltic rhythm. The mid-gut or the hind-gut was excised and placed in a bath of saline medium in which the normal amplitude and frequency of the peristaltic movements are maintained. The medium was prepared in proportions by volume of 5/8 molar solutions of NaCl 200, $MgCl_2$ 40, KCl 2, $CaCl_2$ 2, Dextrose 3, with Na_2HPO_4 to $P_H{}^7$. The saline medium was aerated by leading compressed air through a tube into the medium. Each isolated region of the gut was ligatured at both ends with silk as in the case of the guinea pig's intestine (Hogben and Schlapp 1924)[4]. One end is fixed in the saline medium while the other end is connected to the recording lever. Adrenaline and epinine in dilutions of 1/80,000 and 1/40,000,00 were used for perfusion. Nearly a minute lapsed before the action of the adrenaline started. In the case of the mid-gut the peristaltic rhythm is increased to 7 to 8 waves per minute. In the hind-gut also considerable increase is effected. To begin with an irregularity in the movements was noticed. Uniform amplitude and frequency were restored in two to three minutes.

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4. 11. 1936.

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1. Yonge, C. M., "The mechanism of Feeding, Digestion and Assimilation in *Nephrops Norwegicus*". *Brit. J. Exper. Biol.*, *1.*, 1924.
2. Miller, F. R., "On the Rhythmical Contractability of the Anal Musculature of the Crayfish and Lobster". *J. Physiol. 40.*, 1910.
5. Alexandrowicz J. S., "Zur Kenntnis des sympathischen Nervensystems der Crustaceen". *Zeit. f. Natur. 45. Jen.* 1909.

4. The effects of many internal secretions and drugs on the heart of a large number of crustaceans and the isolated regions of the gut in other animals were studied extensively. See Carlson, "On the Point of Action of Drugs on the Heart". *Amer. Jour. Physiol*; *16*, 1909.
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   Hogben and Hobson. "The Action of Pituitary Extract and Adrenaline on the Contractile Tissues of Certain Invertebrata". *Brit. J. Exper. Biol. 1*., 1924.

   Young, "Movements of Isolated Small Intestine". *Quart. Journ. Exp. Physiol. 8*, 1915.

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SUPPLEMENT—Sectional Presidential Addresses to the British Association for the Advancement of Science

Physics and Mathematics

Trends in Modern Physics

—Prof. Allan Ferguson

In his presidential address to Section A (Mathematical and Physical Sciences), Prof. Allan Ferguson, after referring to the losses suffered by physical science in the deaths of Sir John McLennan, Sir R. Glazebrook, Sir J. Petavel and Prof. Karl Pearson, gives a brief survey of the change in outlook following upon the development of physical science in the twentieth century.

The attitude of the physicists to the fundamentals of science, during the past century, was naively realistic. Evolution and development of mechanics on Newton's lines, the successful extrapolation of laws governing motion of macroscopic bodies down to bodies of atomic dimensions, and the wave theory of light which seemed successfully to explain the mechanism by which radiation is conveyed: these are in short the achievements of scientists of the last generation.

The discovery of electron and of radioactivity and investigations on the energy distribution in the spectrum, revealed the weakness of the classical theory. The disharmony between classical theory and experimental facts was solved by Planck during the closing years of the last century by introducing quantum notions which successfully explained the photo-electric effect and the spectrum of the Bohr atom. With further development of quantum theory, however, there resulted a dualism of outlook, now emphasizing the wave aspect and now the particle aspect of matter and of radiation, which difficulty is now disappearing by the later developments of wave mechanics.

Within recent years nuclear bombardment has resulted in the discovery of the neutron and positron, and to maintain the validity of the conservation laws to all nuclear transformations, the neutrino, possessing no charge and a negligible mass, has also been introduced. The other remarkable discovery in this line is that of artificial radioactivity.

The world picture of to-day has been transformed most by the introduction of the uncertainty principle and its effect on the doctrine of causality. Planck has attempted to save the principle of causality remarking that it can be retained in the happenings of the conceptual world, the relation between events in the perceptual and conceptual worlds being subject to a slight inaccuracy. Dealing with perceptual problems from the point of view of quantum physics is rather difficult and the world has not so many points of resemblance to the perceptual world as had the older schemes, as the wave functions, etc., are not so easily interpreted in terms of the world of sense. But the philosophical problem of the transfer is the same and whatever the form of the picture, the physicist of to-day remains on firm ground if he does not confuse the concept—the world picture—with the percept; if he studies the question of the reality underlying phenomena as a philosopher rather than as a physicist and if he really discards outward models.

Powerful weapons for good and for evil have been placed in the hands of the community as a direct result of the growth of scientific knowledge and the scientist cannot remain forgetful of the effects of his activities on the well-being of the community of which he himself is a responsible member. He must educate himself and his less fortunate brethren in a knowledge of the implications and the social repercussions of his work, whether these repercussions be eugenic or dysgenic. A modest beginning has been made and it is hoped that with increasing knowledge greater elucidation will be made of the complex and difficult social problems arising out of the rapid developments of the last generation.

Chemistry

Chemists and the Service of the Community

—Prof. J. C. Philip

AT the meeting of the British Association for the Advancement of Science held at Blackpool this year, Prof. J. C. Philip, O. B. E., D. Sc., F.R.S., President of Section B (Chemistry) paid great emphasis on the need for the community and the State to realize the importance of the manifold services rendered by chemists to the modern society. In the promotion of natural knowledge, in the understanding of the world around us, in the pursuit of new learning, and in the cultivation of inquiry, chemistry is in the forefront. It has revealed to man the molecular architecture of many of the most complex of natural products, and has rendered possible the syntheses of a host of sugars, alkaloids, orthocyanins and other plant pigments and even of some of those fascinatingly interesting substances—the vitamins and the sex hormones. A study of the behaviour of colloids and enzymes has led to a very significant progress in our knowledge of the physico-chemical changes in the living organism. Another key to the secrets of nature has been provided by a study of the phenomena of catalysis. In all these and many other related fields the rich harvest of discoveries made by chemists has not only increased man's knowledge of Nature but has benefited the community in a very generous measure. The lay critic may talk of the 'jargon' used by chemists and of their apparently useless activities, but one may cite the discoveries of aluminium, of tungsten, of acetylene and similar substances to show that the chemical curiosities of to-day may be of the widest and most important industrial use of tomorrow.

In recent times a need has been felt of 'directed' research, *i. e.*, research with a definite object, *viz*, the discovery of a particular type of dye or drug, the means of purifying or softening water for industrial or human use, the prevention of waste or improvement in an industrial operation, the isolation of a vitamin or the manufacture of rustless steel. A great measure of success has crowned many of these organized attempts. But it must be emphasized that such success depended mainly on an extension of *present* knowledge in these fields rather than on new discoveries alone. Fortunately, most industries in advanced countries now realize the potential value of research and are employing the services of trained chemists in increasing numbers.

The State in Great Britain is also taking a more and more prominent part in fostering these research activities and immensely useful organizations have come into existence. Of these the Department of Scientific and Industrial Research has done very valuable work in connection with rubber, paints, colour and varnishes, sugar and confectionary, non-ferrous metals and other problems. The Chemical Research Laboratory at Teddington has studied the problems of synthetic resins, low temperature tars, high pressure reactions, metal corrosion, chemotherapy, etc. The Building Research Station is engaged in determining the weathering quality of stone and other materials. The Water Pollution Research Board is effectively tackling the problem of the disposal of sewage and trade effluents. Chemists have also usefully co-operated with the State in solving the cancer problem and the problem of smoke abatement.

Prof. Philip has justly pointed out the absurdity of connecting the activity of chemists only with pharmaceuticals and explosives and emphasized that it is the weakness and backwardness of the human spirit which is responsible for the perverse uses to which chemical discoveries have been put. The modern chemists, however, increasingly feel that they should band themselves together against such a prostitution of their science and such a debasing of our heritage of intellectual and spiritual values.

The 'chemical profession', which should now take its rightful place beside the medical and the engineering professions should now stand as one man for the common interest of chemists as a whole. 'Serving the community' has been for them not merely a slogan but has constantly been an ideal which they have amply lived up to. If the profession has not so far united it has been due rather to the diversity of the spheres of work and interests, than to the absence of any need for such concerted action.

There are now in Great Britain about 12,000 trained chemists most of whom are members of either the Chemical Society, the Institute of Chemistry, or of the Society of Chemical Industry. The first of these bodies is also the oldest (established in 1841) and has notably achieved its object of publication of new knowledge in pure chemistry, and the building up of a comprehensive library. The Institute was established about 50 years ago, is a powerful professional organization, and has a membership now which connotes sufficient guarantee of professional competence. The Society of Chemical Industry (established in 1881) aims at the promotion of applied chemistry. Besides these main bodies there are many smaller organizations concerned more or less with chemistry—the Bio-chemical Society, the British Association of Chemists, the Faraday Society, the Institute of Brewing, the Institution of Chemical Engineers, and the Society of Public Analysts.

A notable consolidation of the Science and of the profession of chemistry has been effected within the last 2 years by the formation of the Chemical Council which has combined the 3 chartered organizations already mentioned as well as the Association of British Chemical Manufactures. This body has been set up for 7 years in the first place, but is sure to be continued and is now seeking to consolidate and unify the chemical profession by acquiring adequate central premises and keeping a complete register of trained chemists. For such registration the qualifications ought to be a broad, general education for character, culture, and citizenship, accuracy in observation and statement, understanding of logical reasoning, interest and delight in the natural world, the appreciation of scientific discovery and its meaning for human life. Prof. Philip deplores the lack of balance in the school curricula in which more emphasis should be laid on biology and on the German language than on specialist work in any subject, *e. g.* physics, chemistry, or mathematics.

After passing the Intermediate Science stage, the training of a student of chemistry should be on broad fundamental lines rather than on narrow specialization for specific chemical occupations or to the excessive study of some academic aspect of the subject. This would prevent any weakness in the grasp of fundamentals which should always receive emphasis, however desirable may be an acquaintance with newer knowledge and newer ideas, for some of these may have only ephemeral interest.

It should not be impossible to devise a scheme of training in schools and universities whereby some vocational training may be broadly based on a foundation of scientific knowledge, where a knowledge of fundamental principles is coupled with practical competence, craftsmanship, and technique, and where proper importance is given to accurate quantitative analysis. Proper emphasis should also be given to two study of subsidiary subjects in an honours course and a wide choice should be offered in these subjects. For making a graduate a mature member of the profession it is desirable that he should begin his further experience outside the university under actual industrial conditions as soon as possible. For other graduates a post-graduate course of further study and research of one or two years' standing in the university should have the way for more intensive work in some special fields, specially for those with a distinct originality and with ambition to extend the bounds of knowledge. For others the post-graduate period may be profitably spent in acquiring special knowledge, in some particular field, *e. g.* in bio-chemistry, agricultural chemistry, metallurgy, the chemistry of food and drugs, etc. A large number of openings are now available for chemists and a higher level of training and competence should be aimed at. But the highest object for chemists in any country should be the wise use and distribution of the natural and synthetic products which science has put at our disposal.

Geology

Palaeontology and Humanity

—Prof. H. L. Hawkins

Palæontology gives no direct evidence as to the origin of groups, of whatever taxonomic grade; its scope is limited to records of the later stages in the careers of groups already in existence. This is not to deny that the presumptive evidence for the birth of new types is overwhelmingly strong; but actual tangible proof of their parentage and generation is lacking. A palæontologist is more of an undertaker than a midwife.

Again, fossil evidence cannot give convincing demonstration of the origin of structures in organisms; its scope is restricted to observation of the fate of those structures after they have appeared. There must always be a theoretical quality in attempted explanations of the development of new characters; there are facts recording what happens to them in course of time.

The only language which adequately expresses the nature of morphogeny is that used in description of individual life. Structures, once originated, pass through stages of development, modification and amplification that are closely analogous to the phases of personal history, both physical and psychological. There is a continuous duplicity, in that intrinsic characters are involved with external requirements; environment is educative but not creative. There is a limit to the response to environment possible for any structure; if that limit is exceeded, disaster results. Every character of an organism, like every complete creature, is more responsive to environmental influence in its early history than latter. Directions of development induced or encouraged by environment become gradually ingrained; just as practices oft repeated become ineradicable habits. In contrast with modern municipal tendencies, trolley-buses are transmuted to trams.

The several characters of an organism are at once independent and inseparable; each can follow its own line of development, but unless a balance is kept within the whole series, collapse is certain. Just as different groups of organism show very different evolutionary speed, so the various structures in a single organism become modified at varying rates. The attainment of mature perfection from a stage of immaturity can never be more than a transient phase on the way to a fresh disproportion comparable with senility.

Structures, and with them the organisms to which they belong, grow old, exhausted or hypertrophied by their own intrinsic expenditure of evolutional 'effort' amid an ever-fluctuating embarrassment of circumstance.

We come to the conclusion that the oracular recommendation to know ourselves is a guide to the secret of evolution. Physically and (in the human case) psychologically we live our lives as compromises between hereditary tendencies and environmental requirements. As we grow older our accumulated load of compromise becomes an obsession, reducing our capacity for further efforts of the kind; and our environment never tires in its changefulness.

If we consider these principles in the light of the struggle for existence, we find that those types which can attain the most perfect harmony with their environment will flourish proportionately. But their success brings Nemesis in its train; for speedy evolution towards dominance implies continuous speed: the perfection point is passed by the same momentum that reached it. Undoubtedly the victor in the struggle for existence wins the prize: but the prize is death.

When we attempt to apply to human affairs the principles of evolution as shown in palæontology, many difficulties appear. Not the least of these is the impossibility of a dispassionate outlook; we are proverbially unable to see ourselves as others see us. Another serious difficulty arises from the shortness of the time during which our species has existed, and the paucity of reliable evidence that it has left of its history.

The mental powers of man are those that place him in a category apart from other creatures. By the exercise of his wits he can find compensation for structural shortcomings, and challenge, defeat, and control all other living things. With the help of the machines that he invents, he can project himself successfully beyond the normal range of terrestrial animals, transporting his body and his habit over the sea and through the air. He can, within fairly wide limits, overcome the influence of environment.

With no intent to belittle the mechanical achievements that have brought man to his commanding position, we must admit that few of them can be claimed as original. They are copies, often improved editions, of devices that already existed in the animal creation, coupled with applications of natural forces that are as old as the world. Man's capacity for generalization has enabled him to foresee the effects of his inventions, and so to reduce the time that would otherwise have been spent on the costly method of trial and error. He can transmit his experiences to his own and following generations, so preventing (for those who listen) a wastefnl repetition of mistakes. The speed with which he has beaten all other creatures at their several games is commensurate with the degree of his success. Paradoxically he has become supremely generalized by the exercise of a highly specialized faculty.

This analysis leads to a somewhat equivocal result. On the one hand, the high cerebral specialization that makes possible all these developments, and the extraordinary rate at which success has been attained, both point to the conclusion that this is a species destined to a spectacular rise and an equally spectacular fall, more complete and rapid than the world has yet seen. On the other hand, the wide range of directions into which the specialization extends, and the measure of control over environment that it entails, seem to suggest a peculiar kind of plasticity that might pass for generalization, with the consequent hope of a long time-range. In this uncertainty we must look for such facts as are available, facts of history which are at least comparable with the record of palæontology. But first we must estimate the relative value of the evidence afforded by human history.

At the outset we must admit that the basis of our analysis of mankind will be on a different plane from that which we employ in the case of other organisms. Morphological and physiological characters change so slowly that we cannot expect to find much alteration during our brief career; and in any case there is practically no evidence of that sort available. But if the conclusions already reached as to the universality of the law of evolution are accepted, it matters not a whit which particular attribute of an organism we select for study. Behaviour is but an expression of the reaction between the qualities of an organism and its environment, and civilization is a kind of behaviour. This argument is not so specious as it may appear, for the evidence available to check its validity is ample.

The outstanding physical peculiarity of the human species is its upright posture, a feature to which many of its bodily structures are far from completely adapted. In spite of its relatively large size, the human body cannot be claimed as exceptionally capable. A man stripped of the instruments of his devising, left to compete on equal terms with the other occupants of his restricted environment, would stand no better chance than they. It is true that he could perform most of the actions expected of land animals, but none of them superlatively well. Were he compelled to rely on his bodily characters alone, there would be little more reason to single him out for special consideration than there would be the capacity to do so.

Fossils and historical documents alike give but a fraction of an account of the matters of which they treat. In both cases the story of the early stages of racial progress is imperfect and often mythological; the episodes of decline and fall are more fully documented. But, in contrast to palæontological evidence, human accounts are always suspect. Written records of events represent an impression made on one or at best a few minds; they may, indeed they must, be tainted with prejudice and ignorance even when they are not deliberately falsified. The impious rebellion of one writer is the glorious revolution of another. Whatever may be the criticisms levelled at the transcribers of Natural History, no doubts can be cast on the essential truth of the record they try to interpret.

Again, the bulk of human history is the record of the performance of a few actors on a specially selected stage; palæontology, with all its imperfections, gives a picture of events in fairer proportion. The parts of human history usually recorded represent the activities of man the intensified animal rather than of man the half-fledged angel. The behaviour of the animal is the more rational, and so easier to remember and describe. But from very early times another factor has entered into human affairs—a factor illogical and wayward, but every bit as real to a man as his animal qualities. This factor, which we may call 'altruistic,' makes human actions often unintelligible.

Nevertheless, man leaves other traces of his activities besides written screeds, and many of these records are as revealing, and as unintentional, as the shell of a mollusc. By piecing together archæological materials, and fitting documentary accounts into the plan of this mosaic, a conception of human history can be gained that comes within measurable distance of scientific evidence.

It would be wearisome to reiterate the various features wherein the history of human affairs corresponds with the course of evolution in other groups. Whether we consider individual lives, dynasties or empires, the same depressing story applies. Some races, once dominant in their particular sphere, have disappeared entirely; others, fallen from high estate, linger in inglorious decay. But all of those brave civilizations and empires of which we have records seem to have shown a succession of similar histories. They have risen from obscurity through possession of successful attributes, and have reached the peak of their power only to pass it. Some have rotted away quietly, others have fallen before the onset of less rotten stocks or pehaps of extra-human disaster. Many of the early empires were on so small a scale that their rise and fall had merely local effect; others have been more comprehensive, and their dissolution has spread havoc over wide areas of the world.

Until comparatively recently, there has been a persistent proportion of 'backward' types, unaffected by the civilizing influence of the progressive powers. These have remained as a quiet background to the transient pyrotechnics of the others. They remained to provide a new upstart when the current one had crashed. To-day there are few races of this kind left; almost all of mankind has encountered civilization and either perished or been transmuted. The fatal complexity of civilization grips the whole species, crushing it into unity.

The specific causes of the collapse of once dominant races are doubtless varied ; but there is general agreement that one universal factor in disintegration is complexity, an aspect of over-specialization. The units of an empire, be they individuals or factions, tend to work together in harmony during the period of upward struggle ; but when a position of dominance is won, they continue to struggle. When there are no new worlds to conquer they begin to fight among themselvees. Selfish aims replace patriotic ones, and the community becomes discordant.

The correspondence between the state of affairs and the morphogenetic trends in other races of animals is so close that it needs no elaboration. Those who deny that human institutions are subject to the laws of organic evolution know either no history or no palæontology. Many proverbs give epigrammatic statements of the principles of evolution in imaginative terms.

'Ill fares the land, to hastening ills a prey,
Where wealth accumulates and men decay.'

The history of extinct empires, which should be studied as a cautionary tale, is commonly regarded as providing an example to be followed. Human nature has the curious trait of gambling against the laws of cause and effect. We always hope that the fate that befel our predecessors will pass us by. Babylon, Egypt, Rome, Spain all traversed the same track ; and to-day we follow in their footsteps hoping to reach some different goal.

Zoology

Natural Selection and Evolutionary Progress

—Dr. J. S. Huxley

Biology at the present time is embarking upon a phase of synthesis after a period in which new disciplines were taken up in turn and worked out in comparative isolation. Nowhere is this movement towards unification more likely to be fruitful than in the many-sided topic of evolution. With the reorientation made possible by modern genetics, evolution is seen to be a joint product of mutation and selection. The two processes are complementary.

According to modern conception, the notion of Mendelian characters has been entirely dropped. Instead of a given gene having a constant effect, its actual effect is dependent upon the co-operative action of a number of other genes.

Evolution need not occur by a series of sharp single steps ; each such step is immediately suffered by ancillary changes in genes and gene-combinations. What evolves is the gene-complex ; and it can do so in a series of small, if irregular, steps so finely graded as to constitute a continuous map.

Dominance and recessiveness are to be regarded as modifiable characters. Dominant genes, or most of them, are not born dominant ; they have dominance thrust upon them. Mutations become dominant or recessive, through the action of other genes in the gene-complex.

There remains the difficulty that most mutations so far investigated are deleterious. Mutations which are deleterious in what may be described as normal conditions may become advantageous either in an altered environment or in an altered genic background, and many mutations or Mendelizing variations cannot be described as intrinsically useful or harmful, but vary in their selective effect with variation in environmental conditions.

Whatever other processes may possibly be at work, selection is constantly operative. A difference in environment may decide between two genes with sharply contrasting effects; quantitative differences in conditions may lead to complete reversal of advantage between varieties; the gene-complex may be selected so as to protect the species from the deleterious effects of mutations, or so as to minimize the ill effects of an otherwise advantageous mutant. In these and other ways natural selection proves itself to be a pervading, active agency.

It is logically obvious that every existing species must have originated from some preexisting species, but it is equally clear on the basis of modern research that it may do in one of several quite different ways. Species-formation may be continuous and unilinear; continuous and divergent, abrupt and convergent; or what we may call, reticulate, dependent on constant intercrossing and recombination between a number of lines, and thus both convergent and divergent at once.

From the standpoint of natural selection species fall into two contrasted categories. On the one hand we have those in which natural selection can have had nothing to do with the origin of basic, specific characters, but merely acts upon the species as given, in competition with its relatives. These include all species in which character-divergence is abrupt and initial. On the other hand we have those in which character modification is gradual. Here natural selection may, and on both deductive and inductive grounds often must, play a part in producing character of the species. This helps to bring home the heterogeneity of the processes which we lump together as evolution.

Coming to the problem of adaptation, we can say that both structurally and functionally every organism is a bundle of adaptations, more or less efficient, co-ordinated in greater or less degree. But how has adaptation been brought about? All that natural selection can ensure is survival. It does not ensure progress or maximum advantage, or any other ideal state of affairs. Most adaptations clearly involve many separate characters, and when we can study their actual evolution with the aid of fossils, we find that it is steadily progressive over tens of millions of years, and must therefore have involved a large number of steps. The improbability is therefore enormous that they can have arisen without the operation of some agency which can gradually accumulate and combine a number of contributory changes: and natural selection is the only such agency that we know. Natural selection is all the time achieving its results by giving probability to combinations which would otherwise be in the highest degree improbable.

The evidence that we possess goes to show, first, that selection can be very efficacious in altering the mean of a population within the range of existing variability; secondly, that a relaxation of selection will allow the type to deviate away from adaptive perfection, quite outside the range of variability to be found where selection is more stringent, and, thirdly, that adaptive characters may advantage their possessors in such a way as to exert a selection pressure in their favour, and that accordingly selection can have a continuous guiding effect towards adaptive perfection.

It is hard to understand why the trends seen in adaptive radiation have been adduced as proof of internally determined orthogenesis. Wherever they lead to improvement in the mechanical or neural basis for some particular mode of life, they will confer advantage on their possessors and will come under the influence of selection; and the selection will continue to push the stock further and further along the line of development until a limit of perfection has been reached. Once a trend has begun, much greater changes will be necessary to switch the stock over to some other mode of life than to improve the arrangements for the existing mode of life ; and the further a specialized trend has proceeded, the deeper will be the groove in which it has thus entrenched itself. Specialization, in so far as it is a product of natural selection, automatically protects itself against the likelihood of any change save further change in the same direction.

It is a common fallacy to think of natural selection as first and foremost a direct struggle with adverse weather, with enemies or with elusive qualities of prey. The most important feature of the struggle for existence is the competition of members of the same species for the means of subsistence and for reproduction. In general intraspecific type of selection is more widerspread than interspecific.

It is another fallacy to imagine that because the major elimination of individuals occurs in one period of life, therefore selection cannot act with any intensity on the phase of minimum numbers. Selection, in fact, can and does operate equally effectively at any stage of the life-cycle. Haldane has stressed that the results of selection at one period of life-cycle may have repercussions on other periods and affect the species as a whole in unexpected ways.

The type and course of evolution may be altered according to the type of organism or of biological machinery on which it has to work. Haldane has demonstrated that only in a society which practises reproductive specializations, so that most of the individuals are neuters, can very pronounced altruistic instincts be evolved, of a type, which 'are valuable to society but shorten the lives of their individual possessors'. Thus, unless we drastically alter the ordering of our own reproduction, there is no hope of making the human species much more innately altruistic than it is at present.

It is a common fallacy that natural selection must always be for the good of the species or of life in general. In actual fact we find that intraspecific selection frequently leads to results which are mainly or wholly useless to the species as a whole. Intraspecific selection may even lead to deleterious results. This is specially true with intrasexual competition, between members of the same sex of the same species. Intraspecific selection on the whole is a biological evil. The effects of competition between adults of the same species probably 'render the species as a whole less successful in coping with its environment'.

The conclusion is of far-reaching importance. It disposes of the notion that all man needs to do to achieve further progressive evolution is to adopt the most thorough-going competition. But we now realize that the results of selection are by no means necessarily 'good', from the point of view either of the species or of the progressive evolution of life. They may be neutral, they may be a dangerous balance of useful and harmful, or they may be definitely deleterious. Natural selection is efficient in its way—at the risk of extreme slowness and extreme cruelty. Both specialized and progressive improvements are mere by-products of its action, and are the exceptions rather than the rule. For the statesman or the eugenist to copy its methods is both foolish and wicked.

There has been a trend during evolution which can rightly be called progressive and has led to a rise in the level of certain definable properties of organisms. The properties whose rise constitutes biological progress can be defined in the broadest terms as control over the environment and independence of it. One-sided progress is better called specialization. And the chief characteristics which analysis reveals as having contributed to the rise of dominant groups are improvements that are not one-sided but all-round and basic, such as temperature regulation or placental reproduction.

So much for the fact of progress. What of its mechanism ? It will be clear that if natural selection can account for adaptation and for long-range trends of specialization, it can account for biological progress too ; for progressive changes have obviously given their owners advantages. Sometimes it needed a climatic revolution to give the progressive change full play, as at the end of the Cretacious with the mammal-reptile differential of advantage : but when it came, the advantage had very large results—wholesale extinction on the one hand, wholesale radiation of new types on the other. It seems to be a general characteristic of evolution that in each epoch a minority of stocks give rise to the majority of the next phase, while, conversely, of the rest the majority become extinguished or are reduced in numbers.

One somewhat curious fact emerges from a survey of evolutionary progress. It could, apparently have pursued no other course than that which it has historically followed.

The final step taken in evolutionary progress to date is that to conceptual thought. This could only arise in a monotoccus mammal of terrestrial habit, but arboreal for most of its mammalian ancestry. All other known groups of animals are ruled out. Conceptual thought is not merely found exclusively in man: it could not have been evolved on earth except in man.

Only along one single line is progress and its future possibility being continued—the line of man. If man were wiped out, it is in the highest degree improbable that the step to conceptual thought would again be taken, even by his nearest relatives. In the ten or twenty million years since his ancestral stock branched off, these relatives have been forced into their own line of specialization, and have quite left behind them that more generalized stage from which a conscious thinking creature could naturally develop.

What of the future?

Conscious and conceptual thought is the latest step in life's progress. It is, in the perspective of evolution, a very recent one. Its main effects are indubitably still to come. Man is not destined to break up into separate radiating lines. For the first time in evolution a new major step in biological progress will produce but a single species. We can also set obvious limits to the extension of his range. Thus the main part of any change in the biologically near future must be sought in the improvement of his brain.

After most of the major progressive steps taken by life in the past, the progressive stock has found itself handicapped by characteristics developed in earlier phases, and has been faced to modify or abandon these to realize the full possibilities of the new phase. The problem immediately poses itself whether man's muscular power and urge to hunting prowess may not often be a handicap to his new mode of control over environment, and whether some of his inherited impulses and his simpler irrational satisfactions may not stand in the way of higher values and fuller enjoyment. The evolutionary biologist is tempted to ask whether the aim should not be to let the mammal die within us, so as more effectually to permit the man to live.

If we wish to work towards a purpose for the future of man, we must formulate that purpose ourselves. Purposes in life are made, not found. And this human purpose can only be formulated in terms of the new attributes achieved by life in becoming human. Progress is a major fact of past evolution, but it is limited to a few selected stocks. It may continue in the future, but it is not inevitable; man must work and plan, if he is to achieve further progress for himself and so for life.

Economics

The Nature of Plantation Agriculture

--Dr C. R. Fay

Plantations play an important part in the export agriculture of India. According to the Royal Commission on Agriculture in India of 1928, 'The three main planters' crops are tea, coffee, and rubber, but sugar-cane is important in Bihar as are spices in the south of India. The area under indigo in Bihar, where it was the principal planters' crop, is now negligible. The total area under tea, coffee, rubber, and Indigo in 1925-26 was 1,169,000 acres of which 982,000 acres were in British India...A little cincona is also grown by the planters'. Of the total value of exports accrued from these crops, tea alone accounts for $\frac{4}{5}$ths which amounted to Rs. 29 crores in 1926-27.

The plantation has a history of its own. It was first created by the English overseas beginning with Ulster and extending to America. Out-rivalled and dispossessed in North America, kept out in our time from the policy of Government from the tribal economy of West Africa, the planters found a new home in the Dutch West Indies. Indigo and saltpetre are the two early important exports in the economic history of India. The former has been replaced by aniline dyes and the latter by Chile saltpetre. In a similar manner coffee which was supplied to the European market from South India, Ceylon, Java has now its centre of production in Brazil which supplies about 60% of the world's indigo consumption and can easily supply the whole. On the other hand cincona and rubber plantations in the East have ousted the wild product of South America which was their original habitat. Indian lac may also be mentioned in this connection which has displaced the cochineal of Central America. Thus there has been an age-long rivalry of supply between Latin America and Tropical East.

Indigo as the name signifies has its origin in India but towards the close of the seventeenth century the trade was lost to Latin America to revive at the end of the eighteenth century when a fresh demand for navy blue arose. The planters of the seventeenth century were the peasants themselves and the Dutch traders would buy these products in the town from Hindu or Moslem merchant middlemen who would make advances against indigo some months beforehand, binding the debtor peasants to sell to no one else. Towards 1800 the revival of indigo was due to the European planters in Bengal. They took the place of the Indian merchants and set up factories in areas of supply and manufactured the raw produce by improved machinery. They were also assisted by the East India Company which advanced large sums of money to the industry, encouraged its servants to take up planting and relaxed in favour of the planters its monopoly of trade. As the land was already in the hands of the ryot they could not own and operate both factory and land. They made advances of money which gave them a lien of the ryots' crop at a fixed price and reinforced their position as a creditor by acquiring zeminder rights over the cutivator. Thus the relation between the peasant and the planter became that of perpetual debtor and creditor. The situation was aggravated when the planters having formed an association fixed the price of the crop which is much below the cost of production. This led to a grower's strike and disorders and a subsequent appointment of a Royal Commission. Its report in 1860 shows that the planters had been guilty of seizures and detention of ryots.

But throughout the nineteenth century the indigo planters owned some land and to that extent they were true planters. This was called Nij-joti and the majority of it were on the land of new alluvial formation in Eastern Bengal which was most suitable for indigo. But it was thought that it would be impossible for Nij cultivation to replace ryot cultivation, for ryots were already in possession of good lands and the planters could not obtain compact estates. Therefore, after 1860, the planter would make loans and would receive as compensation a sub-lease of the ryot's holding over which he already had general zeminder rights. Thus at the close of the indigo period a full plantation system with factory and field was adopted and in 1890 about half of the 240,000 acres under indigo in Bihar were cultivated by the planters.

In order to see how a new industry might have evolved under the twentieth-century conditions we may turn our attention to tobacco. The task of the British American Tobacco Company which handles about 40 million lbs of tobacco has been to introduce tobacco of the Virginia type to Indian consumers and then to manufacture this kind of leaf in India itself under a protective tariff. Its problem was to secure adequate supplies of leaves of the right type. So the Company in addition to its factories has a leaf development section who with the help of expert botanists issue seeds to the ryots who grow the new varieties of tobacco too eagerly around Guntur. But when the indigo planters tried to improve their product by the issue of selected seeds, the ryots refused to take it lest this would count as a money advance of the old type which would put them in permanent bondage.

Assam, South India, and Ceylon supply most of the tea consumed by Great Britain. Ceylon is naturally favoured both with climate and altitude for production of tea. It has two monsoons and rainfall is sufficient to promote growth throughout the year. Assam has got only one monsoon and being outside the tropics there is also a cold winter when the plantations are closed down. South India has a shorter off-season due to drought. The low coastal land of Ceylon is devoted to cocoanut plantation, middle land is devoted to rubber, cocoa, and tea, and the highland is exclusively monopolized by better quality of tea. But Ceylon has a small area and consequently high price of land. In South India along the Western Ghats plantations are of recent growth and there is more room for expansion. Most tea estates have an adjoining tea factory and in this factory tea leaf is carried to its final processed form; when it arrives over-seas, it only requires to be blended to be ready for consumption. On the other hand coffee and rubber estates, unlike tea, require very elementary factories for bringing their raw product to a half finish and thereafter they export their half-processed stuff overseas for turning into a finished article. Tea industry has one advantage in that it is a leaf and not a fruit and as such it is less susceptible to damage by pests and natural severities.

The optimum size of a mature estate is generally given as 500 acres. With primitive roads and bullock-cart transport of leaves an estate with much over 500 acres is impracticable. But mechanical transport and electrical operation may run a tea estate over 800 acres.

There are four different types of plantation to-day.

1. The proprietory planter. This type of plantation scarcely exists. The man who is called planter is in fact a salaried man.

2. The small companies. These are most representative of plantation of Ceylon to-day. They have London shareholders and directors and their agents in Ceylon.

3. The large companies. Some of these companies in Ceylon have got other plantations, such as rubber, cocoanut in addition to tea. In prosperous days of about 1925 they declared a dividend of 60%.

4. The consumer companies. These companies have organizations in Great Britain for disposal of their produce, both wholesale and retail. They operate estates from which they get a portion of their supplies. Lipton, Brooke Bond, etc., belong to this class.

In laying out tea estates where jungles abound recruitment of labour must be made from a distance. This may be called a special case of migration. In the Darjeeling area much of the land is too high for the plains people and the labour is derived from the voluntary migration of the people from Nepal and Sikkim. Seventy years ago Assam was uncultivated and nearly uninhabited. In the nineteenth century the planters had to adopt virtually a system of indentured labour with severe penal contracts. They obtained their main labour from the primitive tribes, people of the Santal Parganas and Chota Nagpur, by methods which degenerated to slavery. The mode of recruitment was prohibited and propaganda and advertisement by the agencies were forbidden. The Royal Commission in 1931 recommended that a recruiting body representing Indian as well as European planters should be allowed to open recruiting depots and that no recruitment should be forwarded except through these depots and that for the protection of these recruits a Protector of Immigrants with power to work inside Assam should be appointed.

The problem of recruitment of labour in South India is much easier. Labour, especially from Malabar, comes to the estate and returns to a nearby home once a year.

In Ceylon, Tamils from India mainly supply the labour force of the estates. They have in the past paid periodic visits to their old homes but the younger workers are coming to regard the estate where they work and perhaps were born as their home. Here labour movement is strictly controlled and there are no abuses.

In South India a male worker earns 6 to 7 annas a day for a definite task of digging, while a woman worker in the hot weather when the crop is short earns about 2 to 3 annas a day, but in the flush season they earn perhaps a rupee. In Ceylon, the standard rates are:—Man Rs 11 a month, wife Rs 9 and two children Rs 14 a month and thus the income of a whole family comes to Rs 34 a month while monthly expenses of such a family for the main foodstuff may be calculated as Rs 20 a month.

Both in South India and in Ceylon the estates provide excellent hospital facilities. They have to fight continually against malaria and hookworm. During epidemic the planters take charge of their own people and the neighbouring villages. In Ceylon, housing the labourers has been muchmore improved than before. The huts are made of cement with concrete walls with verandahs 6 ft wide. Each room has its own chimney and fire-place and is sufficient for 3 or 4 people.

Generally, the growers of principal crop of a country form an association for looking into the interests common to themselves. The planters of Ceylon have their Planters' Association to which the members subscribe on acreage basis. Over and above they pay a number of export taxes or cesses which in April 1936 amounted to the following per 100 lbs. of tea.

		Rs	Cent
(*a*)	Customs duty (taken to general revenues)	2	00
(*b*)	Medical wants on estates	0	15
(*c*)	Tea research	0	14
(*d*)	Tea propaganda	0	75
(*e*)	Tea control	0	11
		3	15

There is a restriction scheme of exports. In India in 1936 the producers have decided by an informal agreement not to manufacture more than 12% of the estates' basic crop for sale in the domestic market. But in Ceylon they do not take into account their domestic consumption. In both countries new plantations have been greatly restricted. Tea restriction has borne with exceptional severity on the activities of some of the European companies in South India. The planters of Ceylon first came into close co-operation for recruitment and regulation of labour and organization of medical services. But afterwards they felt a necessity for a tea research scheme which was drawn up and financed by the tea industry and established by colonial ordinance. Research was first required for expansion but now it is being utilized for carrying through restriction with least financial and technical damage to different estates.

The International Tea Agreement fixes for each country a standard output. It is the task of each country to assign to its producers their individual share in the country's quota. Thus in Ceylon each estate is given estate coupons for a certain quantity of tea based on past production. The coupon indicates that its owner may export so many lbs of tea and not so much worth of tea. In fact there are small holders who sell their export rights and allow their holding to lie idle. The international authority is the International Tea Committee. It has so far worked satisfactorily. The report of 1934-35 calls attention to some steps which were taken to prevent tea smuggling across overland frontier of India. But the Committee apprehends decrease in consumption in near future and therefore has started propaganda for expansion of market. In 1933-34 the gross world exports may be taken as 800 million lbs of which 520 million lbs came from India and Ceylon, the proportionate export being India 3, Ceylon 2. In rubber again, the British Empire is leading though India and Ceylon subscribe but little. The United Kingdom with her Dominions consumed 540 million out of 860 millon lbs of tea in 1933-34, while the United States which is a non-producing country consumes much more rubber than the United Kingdom.

Engineering

The Engineer and the Nation

—Prof. W. Cramp

In his presidential address to the Engineering Section of the British Association, Professor William Cramp discussed the position of engineer in society and the various problems arising out of this, which, to-day, confront both the society and the engineering profession. He started by pointing out the difference between pure science and engineering. Whereas pure scientists are concerned only with the pursuit of truth as free from worldly care and responsibility as a mediaeval monk, the function of the engineer is to supply the co-ordinated knowledge of the pure scientist and the experience of the ages to the satisfaction of human desire, and to the increase of the amenities of life. He is the link between human experience and scientific knowledge, and, as such, he cannot perpetually live in a rarefied atmosphere of detachment. He must be in daily contact with humanity and learn to understand human psychology as well as human needs. As a result, he is less specialized, more balanced, more adaptable and understanding than his colleague in pure science.

In the growth of our civilization engineering has certainly made the largest contribution. Roads, canals, ships, aeroplanes, telegraphy, television etc. have all come from engineers. The natural effect of these would be to unify humanity and foster friendliness among its different sections. But unfortunately all these can be and are frequently misused by politicians, scaremongers and interested parties for causing death and destruction. So, by a cruel irony of circumstances, engineering which outclasses every religion for the promotion of peace and understanding, also has no equal for battle, murder and sudden death.

To each nation and the world the activities of the engineer and the uses to which they are put are of supreme importance. It is therefore necessary that the nation should accord him a status which will be in keeping with his importance. The doctor in every civilized country is held in high esteem largely because his patients are dependent upon his honour and good faith, as well as upon his knowledge and skill. He is in a position of trust as well as of responsibility, and his conduct is expected to be unaffected by the lure of private gain. On these assumptions, the status accorded to him is deservedly high. It is nationally defined by the General Medical Council and jealously guarded by the British Medical Association and the legal insurance societies. The protection afforded him is great. He may make technical blunders in diagnosis or in treatment, involving even death, or he may neglect panel patients; but neither patient nor relative dare move against him for fear of the professional organization of which he is now a part. On the other hand, except in extreme cases, he knows that his colleagues will view mercifully any untoward 'accidents' and his certificate of death will rarely be questioned.

In sad contrast with this stands the engineer. When he enters his profession after a long period of training, he has no status that is nationally recognized. He is held to be legally and financially responsible if he makes any mistake anywhere in applying his technical knowledge and has no protection, legal or otherwise, from his professional organization when he is attacked. As regards remuneration in public services also the engineer occupies an inferior position to the medical man.

Besides the responsible work which he undertakes and the legal liabilities to which he is exposed, the engineer is often the victim of certain charges laid against him by the preacher and the press. He is accused of being equally willing to lend himself to works of utility and to works of destruction. The reply would be that the engineer has a dual role. As a scientist he is not concerned with the use or misuse of his inventions and discoveries, but he has a human and commercial side as well and in such matters is exactly on a par with the rest of mankind. Again, the engineer is charged with some responsibility for the existing economic chaos. 'There should be a moratorium as regards scientific research and development,' said one. 'The world would have been a better place if the internal combustion engine had not been invented,' said another. 'If it were not for the immense increase of automatic machines and of labour-saving devices, we should not have the problem of unemployment,' says the press. True enough, we should not. But the invention of a machine does not compel the use thereof. Let him who holds these views, return home, scrap his lawn-mower and his wife's sewing-machine, and engage gardeners to cut the grass with shears and seamstresses to hem by hand the household sheets. To rid the world of machine needs a change of attitude towards occupation, and a love of monotonous work for its own sake.

From persons of a diametrically opposite point of view, comes the complain: "If our inventors were more fertile and our engineers more enterprising they could introduce new industries in the distressed areas". People who say this have obviously no idea of the real state of affair. The whole legal system in England is framed in such a way as to thwart the inventor. It is no use taking a patent because defence against pirates is highly troublesome and expensive. Then again certain Government Departments and large firms leave the task of adopting or rejecting a new idea in the hands of persons whose opinion on the subject are worth nothing.

This brief investigation of the relations between the engineer and the nation points to the necessity for certain reforms. Of these, the first is the provision of some body with statutory powers to define the qualifications and status of those who may use the title Civil Engineer, Mechanical Engineer, Electrical Engineer, etc., to prevent unqualified persons from jeopardizing life and check unprofessional conduct. At present, the three great Institutions try to fufil that role, and the Institution of Consulting Engineers has also done its best. But as none of these bodies has statutory powers, the rules that they frame cannot be enforced. By means of an organization that has grown up in one generation, the medical fraternity has progressively improved the standard of qualification, and has earned the nation's gratitude by getting rid of humbugs, charlatans and quacks. The engineer asks for a similar recognition and a like opportunity. But the medical profession and the Bar have also achieved a measure of immunity from liability for which the engineer does *not* ask; believing that therein temptation may be lurking amid the slime of self-interest.

"The second reform is the proper representation of science upon all governing bodies in industry, and upon all technical departments in the state. Here I think this Association can do the nation a service by passing a resolution asking for more adequate representation on the Board of Admiralty and similar state bodies. I should like to see a small Committee of this Section appointed at this meeting to explore the matter further.

"A third reform, dependent to some extent upon the first and second, is some machinery which in technical matters will prevent the engineer from being over-ruled by the commercial man. This is a very difficult subject; but at least a beginning could be made with government and municipal undertakings, where the evil is very pronounced. It is not right that the citizen should run risks of life or health to save trouble or expense to a trading department. The county and borough councils have the remedy in their own hands. On engineering questions the engineer should always have the last word.

"The fourth reform is a drastic alteration of the patent procedure in the law courts. Here, again, I think this Association should help by recognising the existence of this evil and recommending that a Royal Commission be appointed to investigate the subject at once.

"The fifth reform concerns the Trade Associations and can only take the shape of a suggestion. To obviate unpleasant suspicions, and to enable these bodies still to carry on the part of their work which is so beneficial to the nation, I would most strongly advise them to make their Councils fully representative of all the three interests, *viz.*: makers, contractors, and buyers. I think that if they fail to do this, they will slide by degrees into a slough of self-interest, until questions in the House of Commons, or the advent of a Socialist Government, leads to state interference with their organizations.

"Finally, there is the question of the general professional code of the engineer. The only conclusion possible is that the existing conditions of training are lacking in some essential factor. The modern curriculum both in school and university has become so crowded, the teaching so vocational, and the objects so material, that a real perspective of life is impossible. Youths and maidens sail away from the university with excellent intellectual training, but with no sheet anchor to which they can trust in distress. This is true of every faculty: of arts as well as of science and medicine. The result is that when they meet a strong current of self-interest, they drift helplessly, and we see them exhibiting that unsocial behaviour of which I have given so many instances. The remedy lies in the hands of parents and of those who control educational institutions: it is urgent and of national importance. I commend its consideration to the Board of Education, the Committee of Vice-Chancellors, and to the members of Section L. British engineers have, in the past, earned a great reputation for reliability and straight-dealing. This is a national asset of real value; which can only be maintained if, as in our national games, we learn to place integrity before personal advantage.

Anthropology

The Upper Palaeolithic in the Light of Recent Discovery

—Miss D. A. E. Garrod

The outlook in our recent studies in prehistoric archaeology is in the melting pot. New excavations and researches in Africa, the Near East, Eurasia, China, and other parts of the world have called for a new orientation in succession, nomenclature and typology of the several culture stages, especially those of whose appearance in Europe (towards the close of the Pleistocene) marks the extinction of the Neanderthal man and the advent of Homo sapiens. Much anomaly and ambiguity exist. For instance, diverse strains are grouped together under the single heading 'Aurignacian' and are much misunderstood for a typological study. So it is high time that we re-examined the above in the light of new evidences now available and attempted a new pattern as a whole by a change of axis which is already felt.

Miss D. A. E. Garrod, the distinguished President of the section of anthropology in the last session of the British Association for the Advancement of Science, has very nicely reviewed new and old fields of upper Palaeolithic cultures and has drawn interesting conclusions. She attempts to trace those cultures back to their origin and to describe the mode of their development and distribution and finally to construct a general pattern.

The old classification of the Palaeolithic cultures from Chellean to Magdalenian as obtained in France is no longer tenable as a system of universal application and should be demolished as such. Though the old chronology was given later an apparently new orientation by resolving the Stone Age into three cultural elements, the so-called handaxe industry, the flake industry, and the blade industry, in fact, the triple subdivision into lower, middle and upper Palaeolithic remains unaltered. It was Abbé Bruil who first developed a universal outlook from a wealth of materials from very different parts of the world, which caused that change in the axis.

Menghin has recently attempted a new set of nomenclature for the Stone Age cultures. Instead of using the general subdivision into the handaxe, flake and blade cultures, he treats flake and blade cultures as one and creates a third class for bone cultures. But he fails to obviate the chronological and typological duality in the old subdivisions of the lower, middle, and upper Palaeolithic. These labels should be used exclusively in a chronological sense, while the groups of handaxe, flake and blade industries in strictly typological classifications. They should never be made to appear synonymous. Menghin attempts to obviate this error by re-baptizing the lower and middle Palaeolithic as Protolithic and upper Palaeolithic and Mesolithic as Miolithic (assigning to each group its own handaxe, flake and blade industries). But here the continuity between Protolithic and Miolithic which is established beyond doubt is disturbed, and by the introduction of such terms as Epi-Protolithic and Epi-Miolithic he has not freed them from typological significance. So long as we deal only with western Europe, the subdivisions into lower, middle and upper Palaeolithic may be understood ; but where the sequence is not the same, the use of these terms is definitely misleading.

Reviewing the general situation in outline of the blade cultures in Europe and outside as it was twelve years ago, Miss Garrod deals with western Europe where the succession is pretty clear. The lower Aurignacian with the Andi stage and Chatelperron stage, the various middle Aurignacian levels, the upper Aurignacian with the Gravette and Font-Robert stages come in succession, then the lower and upper Solutrean, and finally the six stages of the Magdalenian follow. Outside

Europe, the only carefully studied blade culture is the Capsian culture of North Africa. The Solutrean was recognized as intrusive from central Europe and the Magdalenian as as a highly specialized local development of the Aurignacian. Central and eastern Europe had the upper Aurignacian with objects of bone and ivory with geometric designs. The upper Palaeolithic both in Moravia and Poland appear to have a Font-Robert tradition named Swiderian, which continues into the Mesolithic. Palaeolithic Russia is significant in that it has an oriental facies with an implicated relation to the western Magdalenian.

Next, as modified by new discoveries, a comparative retrospect of those blade cultures grouped under the former Aurignacian is admirably given by Miss Garrod. From a study of the classic area of Perigord, Peyrony emphasizes the intrusive nature of the middle Aurignacian, as opposed to the upper and lower Aurignacian which agree very closely. Peyrony proposes the name Perigordian for these cultures, retaining the old Aurignacian title for the middle Aurignacian, marked by scrapers, burins and split-base bone points. But this theory is too absolute in the complete independence of the two traditions, and the Perigordian, like the former lower Aurignacian, covers too much. The blade cultures of the Iberian Peninsula have been much modified by recent researches. Spain is no longer believed to be a purely Capsian province. Capsian influences appear only in the final stages and a late dating for the Capsian has been proposed. The Italian blade industries present a single facies, corresponding in time to the whole period of the Aurignacian, Solutrean, and Magdalenian of France. A separate name 'Grimaldian' has been generally adopted. In Roumania, the Solutrean industry is associated, as in western Europe, with upper Aurignacian forms. The Swiderian is now established as early Mesolithic. It may be possible in future to establish a Palaeolithic precursor for the Swiderian. In the South Russian plain a probable succesion of the blade cultures has been worked out. Typologically they may fall into two divisions—one, the earliest, characterized by an industry of Willendorf type, the second, by a rather generalized type of the upper Aurignacian. Crimea has a blade industry corresponding to that of Palestine. South Siberia shows a mixture of Mousterian and Aurignacian forms, which suggests its possible connexion with the Far East. The Kurdistan industry, which Miss Garrod explored in a joint expedition, can be compared with the earliest blade culture of South Russia stated above. Palestine, an important site, shows a lower Aurignacian with a Mousterian tradition, followed by a middle Aurignacian of a primitive type. Next comes a rich industry of classic middle Aurignecian which forms the bulk of the Palestine Aurignacian counting in time with the middle and upper Aurignacian and Solutrean of the west. The closing stages of the upper Palaeolithic of Palestine present a distinct industry.

Egypt is apparently an area isolated from the main line of development, since the blade industries proper are unknown there and their place is taken by the Aterian, in which the Mousterian tradition is strong, and by the Sabylian, a peculiar Egyptian culture with diminutive Levalloisean cores, thought to be the parent of all microlithic industries, spreading out from the Mediterranean basin in Mesolithic times.

The erroneous theory that successive Aurignacian invasions entered Europe from Africa is no longer held. It is more probable that blade cultures arrived late in Little Africa. The true blade industry falls in two groups—the Capsian proper and the Oranian. The division of the Capsian into a lower and an upper stage is no longer tenable. Since microliths appear in lower Capsian, it cannot be correlated with the Chatelperron of Europe and must fall in the closing stages of the upper Palaeolithic, if not in the Mesolithic. The prehistoric chronology of Africa as a whole cannot be correlated with that of Eurasia. Africa in upper Palaeolithic times was something of a backwater where Mousterian tradition long lingered till the late arrival of the blade cultures. Even this holds in Kenya, where Leaky ascribes great antiquity to the Aurignacian and hypothetically considers that the blade culture of Kenya is older than that of Eurasia. The survival of a Mousterian culture in Kenya stillbay is certain on Leaky's own dating.

The comparative stock of the prehistoric materials of the areas under review being taken, the President goes to deal with her conclusions and attempts to construct a general plan by re-examining the various stages in the French sequence in the light of evidences now brought forward and tracing each one to its original centre.

The first blade industry to enter western Europe according to Miss Garrod is that of Chatelperron stage (Peyrony's Perigordian I), which is the former lower Aurignacian. This industry does not occur in central and eastern Europe. A similar, though not indentical, culture occurs at the base of the upper Palaeolithic of Palestine. The lower Kenyan Aurignacian may be in part contemporary with this stage in France. According to Leaky, the Chatelperronean may have developed in Kenya by the contact of the Acheulean and the Levalloisean. Against this theory it is pointed out firstly that the upper Acheulean of Palestine is in Clacktonian tradition where Chattelperron forms look intrusive, and secondly in the Kharga Oasis, where Levalloisean flake industry actually forms part of the Acheulean, no Chattelperrons have been found. It is held that the Chatelperron already had an independent existence at the time, having developed in some centre still unknown. Palestine or E. Africa is not accepted as the homeland of the Chatelperronean, but an Asiatic centre within easy reach of both is held to be possible. It is suggested that the home of the Capsian culture is East Africa, where the upper Kenya Aurignacian is nearly typical Capsian and where they have developed from the lower Kenya Aurignacian. It has positively entered Little Africa (already developed) from East Africa via Sahara.

The industry of the Aurignacian proper, which is the former middle Aurignacian, can be traced right across Europe, through lower Austria, Hungary, Roumania, the Crimea, Transcaucasia, Anatolia into Palestine, where it lingered much longer than in Europe. This suggests that the East. Mediterranean coast is not far from its origin which, according to Miss Garrod, must be sought somewhere in the Iranian Plateau and that from its distinctive typology it had an independent evolution.

The next stages in the French sequence are those of La Gravette and Font-Robert, formerly grouped together as upper Aurignacian. As the two stages are very closely related, the names 'lower Gravettean' and 'upper Gravettean' respectively have been proposed. The Capsian origin of the Gravettean is ruled out, since microlithic burins and microlunates do not occur in the Gravettean stages and the female statuettes, so predominant in the Gravettean, are absent in the Capsian. It is suggested that both the Capsian and the Gravettean are derived from the Chatelperronean. From its remarkable development in central and eastern Europe, the Gravettean, it is pointed out, may have a Eurasiatic origin. The fact that Russia shows abundantly the distinctive female statuettes, which occur only sporadically in western Europe, tends to assure an eastern centre of dispersion for the Gravettean. Central Europe may be eliminated, since the Gravettean there is preceded by the Aurignacian. It is possible that the proto-Gravettean could have passed into North-east Europe from the hypothetical Chatelperron centre via Palestine, where the Chatelperron forms show signs of evolution towards the Gravettean type.

Miss Garrod in fine sums up her speculations that in the earliest blade industry the Chatelperronean from an unknown oriental centre, emerging in lower Palaeolithic times and developing, ultimately sends out two branches, one into East Africa to give rise to the Capsian, and the other into North-east Europe to give rise to the Gravettean. Meanwhile the Aurignacian proper pushes westwards and separates the two great provinces. Migrations on a large scale pass into central and eastern Europe along the southern limit of the ice-sheet from the Aurignacian and Gravettean centres and react with one another, producing local variations of the cultures already in possession, the most vital of which was the Magdalenian, finally building up the characteristic French sequence. At the close of the Pleistocene migrations and intermigrations which necessarily follow come to an end and numerous local variations spring up all over the Palaeolithic world.

D. S.

Psychology

The Patterns of Experience

—**Mr A. W. Wolters**

The progress of psychology should not be underestimated and its contribution to life overlooked, because of the presence of many theories of controversial nature. Every science has controversies. The science of psychology being a new discipline the student is confronted with controversies at the very start. Scientific discussions amongst various schools are not to be regarded as disputes. One should make a judicious and critical selection out of the opposing theories and develop it from personal point of view.

Before a previous meeting of the Section Prof. Rubin and Prof. T. N. Whitehead read two papers containing views resembling those of the present writer. In this paper additional illustrations have been put forth in support of the central thesis that our minds organize the presented material of experience into patterns. Prof. Rubin discussed the psychology of visual perception and furnished experimental evidence to show that mind "contributes structural principle to its own experience". What Prof. Rubin showed to be true in case of vision is also true, in the opinion of the present writer, in case of other sensations. The latter supports Rubin's view that meaning and aesthetic appeal of a picture depends on its left-to-right character which, he adds, is determined by our right-handedness.

The manner in which we perceive a thing visually or otherwise is a pre-established one. The mind does not merely register the objective world but organize the sensory material into definite patterns determined partly by original endowment of minds and partly by acquired factors. The experiments of Katz and Thouless on colour and size constancies and those of the Gestalt psychologists on ground and figure amply bear out the contention that the precipient mind arranges the presented objects into patterns.

If it be admitted that the subject analyses the world of objects into patterns it follows that our process of knowing is an activity. Conation, then, becomes a fundamental concept in psychology.

The human and animal behaviours exhibit patterns. Presence of such patterns are observable in our business activities and social dealings. We can estimate the character of an acquaintance by noting his behaviour patterns. The pattern of response may be latent in the organism or may be acquired. The first type of response may be called instinctive and the second skilled. Skill does not merely stand for ability to perform a particular job adequately ; it also indicates a preparedness in an "outline flexible manner" to respond to various details of the moment. Our conceptual thinking can be dealt with in terms of skill in the above sense. The concepts are outline preparations for response. The writer calls them 'schematic preparations' or 'schema'.

The existence of 'social patterns' are clearly observable in our ideas and institutions, and its influence on life may be objectively demonstrated. Prof. Whitehead in his *Human Factor* has shown that by changing the seating arrangement of a group of five girl workers in a factory working in the same room, the output diminished. In group life the individuals accommodate their behaviour to each other's. A disturbance in the social adjustment affects the skill. Our social institutions are outward patterns for adaptive behaviour resulting from the psychological characteristics of one generation to shape the reactions of the next. And an ideal is nothing but a schema of behaviour sufficiently crystallized for inspection but not fully expressible in language. Every response in life is predetermined into patterns and it may be said that there are 'ways of living' as there are 'ways of seeing'.

S. C. M.

Botany

The Uses of Fungi

—Mr J. Ramsbottom.

Following the modern trend of emphasizing the economic aspects of science, Mr Ramsbottom chose "The Uses of Fungi" as the subject for his Presidential Address to the section of Botany at the Blackpool meeting of the British Association. Owing to the incomprehensible amount of damage that these minute non-green plants cause to us, their usefullness and capacity to do good to humanity is apt to be forgotten. As it is true that life on earth would be impossible without the green plants so it is also true that plant and animal life would cease but for these organisms which act as scavengers.

Edible Fungi—From time immemorial people have been using some of the larger fungi as food and some are regarded as poisonous. Apart from the common mushroom which is universally eaten, species like ***Tricholoma personatum*** are regarded as edible in some parts of the country but in other parts are rejected as poisonous. ***Boletus édulis***, figures in many of the restaurants in Sweden where fungus-eating was introduced by Charles XIV. Other forms like ***Cyttaria*** form the main and often the sole vegetable food of the poor people of the Baltic States. Crude methods of producing edible fungi were known from earliest times and consisted of watering old stumps of trees like the poplars for ***Pholiota aegerita*** or masses of earth containing mycelium for ***Polyporus tuberaster*** etc. The field mushroom ***Psallotia campestris*** is one of the few larger fungi that are cultivated to any extent. The French were probably the first to develop its cultivation by growing it on horse-dung. ***Cortinellus shūtake*** and ***Volvaria volvacea*** are also grown. In the art of distinguishing the right type of mycelium the spawn-hunters were more adept than the modern mycologists but the class seems to have disappeared as completely as the professional truffle-hunters, due to the adoption of modern scientific methods for their production on a commercial scale. In 1894 two Frenchmen patented a method of obtaining spawn from the spores but in 1905 Duggar, an American, described how spawns can be obtained satisfactorily from the flesh of the stalk. By this United States, which was then importing about 3,000,000 pounds of canned mushrooms, was enabled to produce 17,000,000 pounds of mushrooms annually—but with the advent of the motor car the proper manure (horse-dung) is becoming scarce and a successful substitute has not yet been found. It is of interest to note that man's most serious competitor the ants have succeeded in cultivating many more fungi in its fungus-gardens.

Truffels and morels have always been highly esteemed but the numerous attempts, to grow them as a crop, have been without success. The truffels (*Tuber sp.*) are hunted out with the help of pigs, dogs, and rarely goats. In India morels (*Morchella esculenta*) are considered as a delicacy in Kashmir where they are known as "gucchi".

The Japanese and the Chinese are great consumers of fungi. *Cortinellus edodes* ("Matsudake") is much liked in Japan and annual picnics in the pine forests are held to search for it. The country also exports about £100,000 worth of another species *Cortinellus shütake* ("shütake"). The Chinese in Formosa greatly like the hypertrophied Canada rice infected with *Ustilago esculenta* which in the young and white condition is krown as "kah-peh-soon". In the ripe condition the black spore powder is used to paint the eye-brows and borders of the hair. The Hottentot ladies similarly use the spores of *Podaxis carcinomalis* as face powder and this suits their special complexion.

FURNITURE—Wood and timbers affected by fungi often become useless but sometimes they too have their uses. The well-known "green wood" of Tunbridge ware is usually oak or birch containing the greenish mycelium of *Chlorosplenium aeruginosum*. Patterns of this wood are cut and glued to furnitures. The "brown oak" much valued by timber merchants is due to the attack of *Fistulina hepatica*. *Armellaria mellea* and *Ustulina vulgaris* form a black line at the limit of their attack and peculiar patterns often result.

OTHER USES—The poisonous fungi also have their uses. *Amanita* is used for religious purposes in Siberia as well as for killing flies. However, not much criminal use appears to have been made of these.

The soft flesh of *Fomes fomentarious* has been used as tinder, caps, aprons, picture-frames and the like. It was with this "touch-wood" that Robert Hook (1665) made the first known observations on the microscopical structure of fungi. Birch-wood infected with *Polyporus betulinus* is powdered and used for burnishing watches in Switzerland. The soft flesh of this fungus once served as razor-strop and entomologists still use it for pinning insects. Bryan in 1923 recommended the use of the "inky juice" of *Coprinus comatus* for retouching and painting out defects in photographic negatives.

LUMINOUS FUNGI—The luminous fungi had their uses in the war to prevent collision when people had to move in the dark. In certain forest areas the luminous fungi and wood were arranged at intervals for lighting purposes.

HORTICULTURE—Orchids are greatly fancied but for a long time their seeds could not be germinated successfully before Bernard showed that the presence of a fungus in the root (mycorhiza) is necessary for abundant germination. Many of the forest trees behave similarly.

MEDICINE—Many fungi are used for medicinal purposes. The most important is ergot (*Claviceps purpurea*) which is used extensively in midwifery and has been retained in the British Pharmacopaea. Russia produces about 100 tons of it annually. Yeast and the dried flesh of *Polyporus officinalis* have been and is still used for various ailments. Yeast extracts are traded under various names such as Marmite which during the war was used as a preventive for beri-beri because of its vitamin B content. Vitamin D can also be prepared from yeasts but certain moulds as *Aspergillus sydouri* or *Paecilomyces varioti* give better results. The sterile bases of the puff-ball *Lycoperdon bovista* has served for staunching wounds and as a styptic in veterinary work. From nuclein of yeast a salt of nucleic acid is obtained which show marked bactericidal action on injection as well as a large increase in the leucocytes.

DRINKS—From the earliest times man has made use of certain fungi for the preparation of alcoholic drinks and beverages. Most of the older processes depend on yeast which convert sugar into alcohol and CO_2. Wines are produced from grape-juice fermented with yeast that occur naturally on the skin of the grape though due to the modern method of using pure culture yeasts as 'starter' the process is a scientifically controlled one. Other fungi like ***Botrytis cinerea***, ***Mycoderma vini*** etc. in conjunction with yeast are responsible for the aging of wines and giving them special flavours.

Almost every nation has its ancient fermented drinks prepared with the help of yeast. To mention only a few—the Kvass of Russia is prepared by fermenting a mixture of barley-malt, ryemalt and rye-flour while the Pulque of Mexico is obtained from the juice of ***Agave*** and is esteemed for its cooling properties. The Scandinavian Taette is a milk product, Sorgho of Manchuria is made from ***Sorghum Saccharum*** and the Nigger beer of East Africa is obtained from millet. Toddy of India is prepared by the fermentation of the juice of Palmyra palm. The well-known Japanese beverage Saké is obtained from rice by the action of ***Aspergillus Oryzae*** and then adding yeast. The mould converts starch into sugar which is then fermented by the yeast. The process is similar to the malting operation where starch is converted into sugar by moulds such as ***Mucor Rouxii, Rhizopus japonicus*** etc.

Some drinks, however, are produced by an association of two or more organisms. The English ginger beer is produced by an yeast ***Saccharomyces pyriformis*** and a bacterium, ***Bacterium vermiforme.*** Mexican Tibi is also similarly produced. The Tea Cider of the tropics which contains 3% alcohol, is held to be a cure for such ailments as consumption, is prepared by the fermentation of ordinary tea with 10% sugar by a combination of ***Saccharomyces Ludwigii*** and ***Bacterium xylinum.*** Kephir used in Western Asia is fermented milk and Koumiss of the Siberian and Caucasian tribes is a similar product obtained from the milk of mare, ass or camel. Egyptian Leben and the Armenian Mazu are also similar drinks.

SAUCE—Arrack is the general name applied to a number of spirituous liquors in the Orient. In Java it is prepared from rice-starch by the action of ***Rhizopus Oryzae, Monilia Javanensis*** and ***Saccharomyces Vordermannii.*** In Ceylon it is distilled chiefly from palm-toddy and in India from palm-toddy, rice, refuse of sugar refineries and mainly from the flowers of ***Bassia latifolia*** (Mohua). Japanese Koji is made with ***Aspergillus***—Shoyu koji is a preparation from soya bean and is employed in the manufacture of soya sauce widely used in the eastern and western countries. Other sauces and food are also made from soya bean products through the action of ***Aspergillus.*** The single fungus ***Aspergillus Oryzae*** in Japan, is responsible for products worth approximately £ 40,000,000 annually and thus it plays an important part in the national economy of that country.

FOOD—Certain changes in food are brought about with the aid of fungi. In baking the CO_2 produced by the compressed brewer's yeast ***Saccharomyces cerevisae*** raises the bread uniformly. The amount of baking yeast produced in Great Britain in 1930 was 2,200 tons with a value of £ 916,000. Dried yeast also serves as food and during the war the Germans produced about 20,000 tons annually for food to supplement the bread ration. The Chinese Red Rice whose origin was long kept secret, is due to the action of ***Monascus purpureus*** on damp rice. The art of making cheese dates from the earliest times. It is prepared from coagulated milk by the action of moulds like ***Penicillium*** which lives in the special caves and wooden shelves of the place where they are manufactured. But now-a-days deliberate infection by the strain of the fungus is practised rather than natural infection.

FUEL—Yeasts can to some extent solve the problem. It has been estimated that English coal will be exhausted in four hundred years and that of U. S. A. in four thousand years if there is no increase in its consumption, whereas if the rapid increase of the recent past is maintained these periods will be reduced to forty and five hundred years respectively. Alcohol seems to be the future substitute and the CO_2 obtained as the by-product in fermentation by the yeast will be, as is even now, solidified to prepare the "dry ice" for refrigeration.

CHEMICALS—Moulds are responsible for the production of many chemicals. Laevo-tartaric acid is obtained with ***Penicillium glaucum*** and gallic acid—a constituent of inks and a mordant for dyes—from tannin by the action of ***Aspergillus***. Glycerine is the main constituent of the highly explosive nitro-glycerine. During the war the blockade of the Allies prevented the import into Germany of fats and oils used as raw materials for the preparation of glycerine but by 1915 the Germans devised a method for its production as a by-product of fermentation of sugars with yeasts, and the monthly output exceeded 1,000,000 kilograms. Acetone used for the explosive cordite can be obtained with ***Mucor Rouxii***.

Takadiastase from ***Aspergillus oryzae*** is a whitish or yellowish powder used where there is a lack of normal digestive activity. Commercially it is employed in the weaving industry to correct oversize of warp threads and to separate the silk fibres composing the thread as spun by the silkworm. It is also used for clarifying the pectin of apple pomace in jam and jelly making and to clear Sorghum syrup. Commercial diastase can replace soap and is a partial substitute to yeast in bread making. The enzyme invertase is prepared commercially from yeast to invert sucrose in the manufacture of various syrups and candy.

Wehmer has shown that by the activity of ***Aspergillus*** and ***Penicillium*** on sugar solutions excellent yields of oxalic and citric acids can be obtained. Gluconic and fumaric acids can also be prepared in a similar way. It was recently stated that a certain American firm in order to supply the colossal amount of calcium citrate required by the American cheese industry alone, is maintaining nine acres of mycelium of ***Aspergillus niger*** in constant commission. From recent investigations it is becoming increasingly evident that compounds of almost every type, known to organic chemistry, can be synthesized from the metabolic products of the moulds. Some species of ***Helminthosporium*** can produce authroquinone which is used in technology as a dyestuff. Penicillir, a metabolic product of ***Penicillium notatum*** has anti-bacterial power though it is non-irritant and non-toxic. Several species of ***Fusarium*** can form large quantities of alcohol from glucose. Certain moulds can also produce fat from sugar and ***Penicillium javanicum*** can give as much as 41·5% fat from glucose. The war had brought about an acute shortage of food in Russia where the "fat yeast" ***Endomyces vernalis*** was used for the production of fat from sugars. The non-pathogenic strain of ***Aspergillus fumigatus*** if added to straw moistened with a small amount of ammonium salt in solution raises the total protein content from one to eight per cent and was used towards the end of war to feed sheep, cattle etc.

A satisfactory parchment membrance have been recently prepared by Sanborn from the somewhat slimy rubbery growth of ***Oidium*** and ***Monilia*** in media rich in carbohydrates. An American patent was also taken out in 1915 for making a leather substitute by tanning a similar growth of ***Bacteria*** and ***Mucor***.

Many of the processes mentioned above have been patented and one can easily see what an amount of mycological and bacteriological information lies hidden in these patents which number a little over 1,800.

"Though a fairly large number of fungi have been investigated, they form a very small percentage of the total. The possibilities of practical results are endless. Here we have a field in which the taxonomist, the chemist, and the physiologist can work together profitably in the cause of science—which is the good of humanity '

A. M.

Physiology

The Control of the Circulation of the Blood

—Prof. R.J.S. McDowall

It is now more than 300 years since William Harvey discovered the circulation of the blood, but we are yet far from understanding its control—a fact which is brought home to us when we realize that each year thousands die from failure of the circulation other than heart disease. Indeed it can fairly be said that certain diseases of the circulation are definitely diseases of civilization and are on the increase.

The purpose of the blood circulation is, as is well known, to supply the tissues with nourishment and particularly with oxygen, and since the different parts of the body vary enormously in their activity from time to time, their needs vary also.

When a tissue, say a muscle, increases its activity, it needs more oxygen and fuel and therefore more blood supplied to it per minute, and this increase is brought about in two ways: (*a*) The heart increases its output and rate, *i. e.*, pumps out more blood with each contraction, and also contracts more frequently than before. (*b*) The blood vessels of the active muscle dilate, so as to increase their capacity, but those in the inactive parts constrict in order, as it were, to squeeze out some portion of their contents into the general circulation to meet the increased need of the active muscle. We must remember, however, that the vessels dilated should not exceed the total capacity of the vessels that are constricted.

The output of the heart depends on the amount of blood that enters it during its diastole, *i. e.*, the more blood reaches it the more it pumps out, within limits.

As regards the rate of the heart, it was usually supposed that it is controlled by two sets of nerves, *viz.*, (*a*) sympathetic, which accelerates the activity of the heart, and (*b*) the vagus, which inhibits it. But recent researches go to show that this is only partially true, because the control is, in reality, under two sets of reflexes, of which the activities of the vagus and the sympathetic are but the efferent parts. This implies that there are also two sets of afferent or sensory impulses which give rise to the motor activities of the sympathetic and the vagus.

There are grounds to assume that the sensory or afferent impulses of the accelerator reflex originate in the skin and their stimuli come from the external world, whereas those of the inhibitory reflexes originate in certain sensitive regions at the aortic arch and carotid sinuses, which are normally stimulated by the pressure of the blood they come in contact with.

During exercise the inhibitory reflexes decrease, while the acceleratory ones increase. The range of acceleration, however, is not determined by the activity of the sympathetic alone. It also depends upon the extent of the inhibition of the vagus activity.

In mild exercise, however, there is no appreciable increase in the rate. There is only an increased output, followed by an increased arterial pressure. This shows that there is at that time a greater quantity of blood circulating through the vessels. But where does the additional blood come from? It comes from those parts of the body which are at that time comparatively inactive and so can go on with less blood. The capillaries of the inactive parts constrict and blood flows out of them into the capillaries of the active parts which open up or dilate in their turn. The dilatation of the vessels is brought about by two means: (1) Chemical and (2) Nervous.

(1) The cause of chemical dilatation has been a subject of considerable debate but there is ample evidence to show that some products of metabolism are responsible for it.

For example, CO_2 and lactic acid have been found to have vaso-dilator action, if applied in suitable concentration. Some substances of protein origin, of which histamine is one, are also responsible for this. Besides these there are some more substances like adenylic acid and others which possess this dilator function. These substances are undoubtedly responsible, if not for the actual dilatation of the vessels during exercise, certainly for the continued dilatation which continues after exercise.

(2) The nervous dilatation is attributed to the action of the sympathetic. This nerve has, in fact, both the functions of constriction and dilatation.

As soon as exercise commences the afferent impulses which set up the vaso-dilator reflex originate from the active muscles themselves and are evidently caused by the mechanical and chemical changes that take place there. Oxygen want, for example, has been known to set up afferent impulses which result in reflex dilatation.

Krogh, by his Indian ink experiment, demonstrated that during exercise large number of previously closed capillaries are opened up and this necessitates more blood to keep up the blood pressure sufficiently high to maintain normal circulation. This additional blood is furnished to the active muscle by almost all other parts of the body excepting the voluntary muscles, the heart muscle and the brain. The vessels of the inactive parts constrict to compensate for the dilatation of the active part. The vessels of the skin have been found to constrict even under the strain of an anticipated activity. It is not quite definitely known how the afferent nerve impulse that result in the sympathetic vaso-constriction arise. In all probability they have their origin in the sensory stimulation from the outside world.

The range of the vasodilator action is not determined solely by the sympathetic. It also depends on the extent of the inhibition of the vagus activity which enhances the vascular reserve by maintaining a tonic dilatation of the vessels. As in the case of its cardio-inhibitory function, the afferent impulses of the vaso-depressor reflexes have their origin in the cardio-aortic region and the carotid sinuses. Like the cardio-inhibitory reflexes again the vaso-depressor reflexes are stimulated by the intra-vascular pressure of blood in these regions.

The primary function of this control of vessels is to maintain the arterial pressure at a constant level which is necessary for a steady flow of fluid to the tissues. But more recently another function has come into light and that relates to the efficiency of the heart.

During exercise the arterial as well as the venous pressure increases. The increase of the former can not be said to be due to an increased peripheral resistance to the flow of blood from the arteries, because in that case it would have been followed by a decreased flow in to the veins. But normally the reverse is the case: there is an increase of the venous flow. This shows that the total circulation is greater at this time. This increase has been effected by the constriction of the vessels of the inactive parts.

Bayliss found that stimulation of the aortic-depressor nerve is followed by a fall of the arterial pressure together with a similar fall of the venous pressure. But it is important to note that the reverse does not take place when the depressor-reflexes are cut off. During exercise, for example,both the vagus restraint of the heart and the depressor-restraint of the vessels are reduced. More blood is thrown into circulation, *i.e.*, more blood flow through the arteries and veins, but this does not necessarily cause an increase of the venous pressure because the heart, at the same time, is stimulated and it promptly deals with this increased venous flow by increasing its output and rate.

A further corroboration of this view of the function of the vaso-dilator reflexes comes from the study of the effects of exercise and emotion in man. It has been demonstrated that generalized vaso-constriction is an accompaniment of psychic activity. Exercise without any psychic gest producesonly a dilatation of the vessels of the active muscles without a corresponding and compensating constriction of other vessels, so that there is an increased capacity of the vessels without an increased flow and consequently the blood pressure naturally falls. This fall in the arterial pressure is not due to the accumulation of the blood in the active muscles, as has been suggested by some, but is due to the decreased peripheral resistance. Accumulation would result in an increased diastolic together with a decreased systolic pressure. But the case is just the opposite of it. From this it follows that the increased arterial pressure which we notice in exercise is due to psychic factors alone which produces a generalized vaso-constriction and calls into use the reserves of blood and thus normal circulation is maintained inspite of this greatly increased capacity of the active muscles.

We must remember, that the same mechanisms that have been described above in connection with exercise are used and developed by the body for physical exercise which it uses to defend itself against disease and injury.

S. K. C.

Educational Science

The Future of Education

—Sir Richard Livingston.

Every individual has a threefold function in the world—to make a livelihood, to be a citizen, and to be a man. The duty of the State is to see that, so far as education is concerned, everyone has the opportunity of performing these three functions. It is easier to make a living than to have the intelligence, the knowledge, and the disinterestedness, which ideally every voter requires. But the final goal of education is, not the capacity to earn one's bread or to live in a community, though these are included in it, but the making of human beings. Body, character, and, in the widest sense, reason make the man. A body undeveloped, a character weak or debased, a mind unaware of the Universe which we inhabit, or the achievements and ideals of mankind, proclaim the failure of education and walk the world as a standing reproach to it.

Hence education, for all men and women, for the artisan and labourer, as well as for the 'educated class,' must find ample room for a liberal, cultural element. Some people may feel that the cultural subjects are unsuitable for the masses. To hold it is to accept the most ruthless of class systems, to say that men differ not only in degree but in kind, and that the majority are incapable of studies without which there can be no intelligent idea either of the Universe or of the greatness of the human spirit. If a man is incapable of these studies, he is not allowed to perform one of his three functions in the world—'to be a man'. And if the majority of the electorate is incapable of them, we must either abandon democracy or resign ourselves to be governed by an electorate which can never know what a State should be. Ancient tradition and political instinct may preserve such a democracy from disaster, but not only will its stability be precarious but its political and spiritual life will be poor. The bad film and the betting news will be its relaxation ; the bad press its literature ; passion, prejudice, the catchword and the slogan will be its masters To this humanistic studies are the great, perhaps the only, antidote. Here are written all the ideals and adventures of mankind ; the lesson of these studies is *Sursum Corda* : they are a perpetual rebuke to the feeble vision and failing faith from which all men suffer, and to the self-contented spiritual mediocrity which is a special danger of democracy; without them men know neither themselves nor their possibilities. How far, then, does our education go to make men or citizens? The measure of its success defines our achievements, its shortcomings indicate what remains to be done. In the fields of university, secondary, elementary, and technical education, the main lines have been well laid. They are not likely to be altered, but in the future they may be improved and elaborated, but perhaps the chief improvement necessary is that we should learn more of their use and purpose. Our worst failures are due to the fact that we drift into and through education in a mechanical, automatic, unthinking way, instead of clearly defining to our own minds what we wish education to do for us and asking whether it is doing it and, if not, why not.

We have left the vast majority of the population without any kind of liberal education. We have provided for the minority who attend secondary school and university. We have shown the rest a glimpse of the promised land and left them outside it. Art, music, science, literature are not for the majority—they are for a few. The rest are disinherited from some of the purest and highest pleasures; they have been reduced to mere machines or animals.

It did not matter so much in the past, when the working-man had little leisure to cultivate these. But the times have changed now, and the working-man has ample leisure to follow these pursuits. The great majority of our population finish their education at the early age of 14, when they can have only learnt to read, write, and do arithmetic, and have thus made only a beginning. But what useful purpose does such a beginning serve, when there is no continuance of these studies? Up till now we have done practically nothing for those who leave school at 14, 15, or 16, and then say farewell to education for ever. The task of the future is to deal with this, our great educational scandal.

When we accept two important principles, (1) that a certain maturity of mind is necessary for humanistic studies; and (2) that full understanding of them is impossible without experience of life, some practical conclusions follow. The first is that an education which ends at the stage of 14 is no education at all. The chief uses of the present system of our elementary education are to enable a minority to proceed to further education, and the rest to read the ***Daily Mail***, ***Express***, and ***Herald***. Unless this elementary education leads on to something else, it is as useful as a ladder which has no rungs beyond one or two at its bottom. To cease education at 14 is as unnatural as to die at 14. The one is physical, the other intellectual, death.

But the defects of our present system will not be remedied by raising the school age to 15 or even to 16. There are no intellectual advantages (there may be and are some economic ones) gained by it. If such a change is preparatory to an education continued into the adult years, well and good; if not, it will leave our problem still unsolved. What is the solution? It will not be found in secondary education, for it is given to pupils whose faculties are not fully developed, and who have not seen enough of life fully to comprehend what education is or what it can do for them. If we lived in Utopia and could reconstruct education without regard either to its past evolution or its present condition or the needs of the practical world, the ideal plan might be for everyone to leave school at 15, and pass into a system where a part of the week was allotted to school, part to earning the living in some practical occupation, the proportions of each varying with the intellectual abilities of the pupil and the demands of the subjects which he was studying. Such a contact with the practical world would both sharpen the appreciation of the value and purpose of education, and, especially in the humanistic subjects, make their real meaning far more intelligible. Theory would be illuminated by practice and practice by theory. At present the two are nearly always divorced. We lead a life of action without thought; or we think in a vacuum, without contact with the realities and problems of the world. Neither form of isolation is satisfactory.

If we can establish a compulsory part-time continuation system, which will carry them to 18, they (the pupils) will remain in contact with those subjects to the rudiments of which their elementary education has introduced them, carrying them on to an age when the mind is growing sufficiently mature to begin to appreciate their value and grasp their meanings. Our next step, therefore, should be to retain those who leave school before the age of 18 under some educational control—not involving wholetime school attendance—to that age. Then the adult education, which is indispensable, should begin. Its great success in Britain is the Workers' Educational Association. In 1935 there were 59,000 students in its classes. Necessarily it has left untouched the vast mass of the population. In Denmark thirty per cent of the small farmer and working-class population attend voluntarily and in part at their own expense, the adult schools, known as the Danish Folk High Schools, where the course lasts for some 5 months, and the education is humanistic in the sense that it is neither technical nor utilitarian. The Danes have been successful with the very classes with which we have failed—those for whom the W. E. A. does not provide. Their achievement is the measure of our failure and the indication of what can be done. The Danes have succeeded because they have a better understanding of the technique of the education of the average man. We have taken too narrow and rigid a view of it. Education of the masses has been conceived as an extension of the existing higher education to the working man. For the majority it has been too academic, too 'high-brow'. To nourish the general, the million, we must enlarge our conception of adult education. Music, drama, handicraft, gardening, and many other subjects are a part of it no less than history, politics, science, and literature. But for the ordinary man, they must be brought into connection with his outlook, interests, mind. For adult education, to be successful, therefore, the intellectual digestion of the masses must be studied. If scholars sniff disdainfully at such popularization, they should be reminded of the dream of St. Peter at Joppa. Following the Danes, we must also make our adult education more social, for even in education man remains a social animal. In contrast with Denmark, Britain will have to face a harder task, for in a country like the former which is essentially agricultural, farmers and small holders may escape from work for a winter, whereas in Britain which is an industrial country the leisure is little for the working-man.

The future lies with adult education. The time, will probably come when man will return to the universities in middle life, to study systematically the newer developments in their own field, to review and revise their own attitudes and habits of thought. Plato was the first to see that the work of education was not complete at the age of 18 or 21 but must continue in a systematic, methodical form into late life. This truth, like his doctrine of the essential equality of the sexes for the work of the State, slumbered forgotten for more than 2000 years : or rather we have slumbered. It is time to awake.

Agriculture

Soil Science in the Twentieth Century

—Prof. J. Hendrik.

In the course of his presidential address to the Section of Agriculture at the last session of the British Association, Professor J. Hendrik traced the history of the growth of soil science as an independent subject with special reference to England. It is almost needless to say that soil forms the most important natural asset to man and as such has been regarded as vitally important by mankind from the beginning of history. An enormous mass of lore, myth, ritual and scientific knowledge grew up around the subject in great complexity among the primitive as well as the civilized communities of the past. Genuine scientific research in soil science and agriculture has begun only recently.

As far as Britain is concerned, the foundation of Rothamsted Station nearly a century ago marks the beginning of scientific research there. It was however a private institution with a limited staff and very restricted facilities for training students. National agricultural education began in a haphazard manner in 1890, and provision for research was made only in 1910. The chief lines of investigations which were undertaken at first—perhaps because it was the easiest and most obvious—consisted of field experiments on the action of fertilizers on crops. Soil by itself was however not yet regarded as a subject for scientific study. Some knowledge of the works of soil scientists of the continent and of Hilgard, Whitney, and Schreiner of U. S. A. was however gradually reaching England, but owing to the linguistic and other barriers, the works of the great Russian soil scientists Dokuchaev, Glinka and Gedroiz were practically unknown before the war.

The most important and valuable agency in spreading among soil scientists of the world a knowledge of one another's work, and especially the work of the Russians, and thus widening the outlook of all, is the International Society of Soil Science founded in Rome in 1924. It grew out of some previous international conferences : first one in Budapest in 1909, next one in Stockholm, the third one in 1922 at Prague and the fourth one was held in Rome in 1924, where the above mentioned Society was founded. The first International Congress of the Society was held in Washington in 1927 and was attended by delegates from many nations. The Russian scientists made a great impression at the Congress and succeeded in converting many to their views which may be briefly summarized as follows. (i) Soil should be regarded as an independent subject for study and not merely as a medium in which to grow crops or as a subsidiary branch of geology, chemistry etc. (ii) Soil is the natural product of a number of soil-forming factors of which the most important is climate and that its nature is not determined by its geological origin. Their great primary classification of soils is into a number of climatic zones. They succeeded in showing that very different soils may be formed from the same rock in different climates, and on the other hand, similar soils may be formed from different rocks in similar climates. (iii) Soils should be classified according to what is found in the soil profile. The profile is a section of the soil from the surface down to the parent material, and is found to consist of a number of different layers. The profile is an expression of the results of the different soil-forming factors and therefore characterizes the different types of soils as produced by the action of these factors. In practice the classification of soils according to the profile studies involves great difficulty specially because genuine profile studies should be made in undisturbed soil (uncultivated) which is difficult to find in densely populated countries. It is also difficult to distinguish between *mature* and *immature* profiles. We are greatly indebted to the Russian School for giving us a fresh start and new methods of attack.

Considering the importance in soil formation of water which passes through the soil, and of the amount and nature of materials in solution and suspension which are washed away by such water, and the importance to soil fertility of the relation of the soil to water, and of the economic importance of drainage in connection with the loss of nitrogen, lime etc, it is a matter of great surprise that more use is not made in soil studies of drain gauges and other similar instruments.

In recent times, there has been a great advance in our knowledge of soil colloids. We know that two types of colloid complexes are found in soils, one mineral and the other organic. The mineral colloid sometimes known as the alumino-silicis complex is found in the clay portion, while the organic colloid known as the humus complex, is found in the decomposed vegetable matter or humus. Our knowledge of these colloids has progressed a good deal and we now know that the process of base exchange is a colloid phenomenon. The application of the methods of X-ray analysis has thrown much light on the structure of clay. Our knowledge of the chemistry of the humus is however still very far from satisfactory.

In the early days of fertilizer industry England occupied an important position, but then her importance diminished. Recently there has been a revival of this industry in England. Continuous research, specially long-range and planned research is necessary if England wants to occupy and maintain a leading position in this field.

SCIENCE AND CULTURE

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Recent Developments in Russian Plant Industry

RAPID development of plant industry constitutes an important feature of the Soviet Union's system of planned economy. The far-reaching character of the results obtained by Russian investigators in this field has aroused world-wide interest; and the Imperial Bureaux of Plant Genetics have rendered a real service to research workers outside Russia by publishing a bulletin on "*Vernalization and Phasic Development of Plants*," in which the recent Russian work has been adequately summarized.

A clear recognition of the difference between the growth and development of an annual seed plant forms the starting point of these remarkable investigations. By growth is understood the increase in weight and volume of the plant at any stage—mere quantitative increase with no change in the physiological quality of the plant tissue. Development, on the other hand, denotes the stages through which a plant must pass in order to attain maturity. These stages represent qualitative changes which should be completed before seeding can take place. Each of these stages of development requires suitable conditions of temperature, light, moisture, and aeration —conditions which may not be favourable for the growth of the plant.

When winter wheat is sown in February or early March in northern climates, both growth and development will be normal in summer and the plants will all come into ear and produce normal seeds. But if the same winter wheat is sown in spring, the plants that are obtained will remain for an indefinite time at the stage of tillering, *i.e.*, their growth continues but development is arrested. A phase of development dependent on low temperature for its completion has been missed and the plant remains immature. The temperature being the governing factor, such a phase is called the *thermostage* of development.

The winter wheat is called a long day cereal, because it has been observed that this plant requires conditions of long day illumination, characteristic of northern latitudes, in order that it may come into ear. If grown in a ten hour day even under conditions very favourable for growth, they fail to produce seed. This indicates the existence of a second stage of development, in which the period of illumination plays the important part, and which is therefore designated the *photostage*.

It is believed that in the development of the plant each stage must be completed before the plant can pass on to the succeeding stage of development, and all the qualitative changes characteristic of all the stages of development must be gone through before the initials of the reproductive organs can be laid down. The most remarkable discovery, in its effect on agricultural practice, has been the fact that the time required for the completion of the thermostage does not depend upon the size of the plant. The changes in plant tissue characteristic of this stage can be brought about in the growing seedling, in the slightly sprouted seed, or even in a seed with an embryo which has just commenced development but not broken the seed coat. The experimental conditions for vernalization *i.e.*, completing the thermostage of the development of the plant in the seed itself, have to be determined for each type of plant, but the underlying principle in all cases is that the dormancy of the embryo must be broken, but the growth should be so retarded that the thermostage of development is completed before the embryo pierces the seed coat. Such seeds have already ceased to be seeds in the physiological sense and have become equivalent to growing plants, though on casual inspection these plants may differ in no respect from the growing seed.

The technique of vernalization may be illustrated by outlining the process that has been adopted for seeds of winter wheat. 100 Kg. of seeds are made to absorb 37 litres of water and are kept at a temperature of 7° to 10° for two or three days for germination to begin. The temperature is then reduced to 0°- 2°C.; which arrests the growth of the embryo, but which is most favourable for the completion of the thermostage of development. The length of exposure to this low temperature depends upon the genotype. The winter wheat Erythospermum was vernalized for varying lengths of time; only those which had been subjected to low temperature for 41 days or more, when sown in spring, came into ear. Late spring varieties of wheat require 10-15 days of vernalization at 5°-6°. There should be proper aeration of seed during vernalization, and the treatment of the seed should be started at a time calculated to yield the finished product on the date of sowing. Mould development is generally avoided by using only healthy undamaged seeds; soaking in ·13% formalin for three minutes, then washing with water to remove the disinfectant is also recommended. Vernalized sowings generally yield mature wheat plants about four months after the date of sowing, and the cultivation of wheat can therefore be pushed up even to those northern latitudes where the ground remains free from snow for four months in summer. The Peoples' Commissariat of Agriculture have conducted experiments in 25,000 farms on an area of 500,000 hectares; compared with unvernalized sowings in control plots, an increase in grain yield of 1·1 centners per hectare has been obtained as a result of vernalization.

Cotton seeds may be vernalized at a temperature of 22°-25°, and, depending on variety, vernalization is completed within 10 to 25 days. The effect of the treatment on cotton, however, seems not so much to be in an acceleration of the inception of the phases of development as in the more rapid completion of each phase. Compared with control plots, there is no significant earlier flower bud formation, but there was an increase in the yield of the first pick, varying from 25-40%. The economic importance of this result may be appreciated easily in those countries where, due to frost setting in early, the first pick is practically the major yield.[1]

Equally important results have emerged from studies on the photostage of development. In the case of long day cereals, it has been found that, contrary to current opinion, the long day requirement holds not for the entire cycle of development of such plants, but only during one particular stage preceding the formation of ear. In many cases of winter wheat, 20 days of continuous illumination have been found sufficient. For the remainder of the life of the plant, light is only necessary for photosynthesis. Plants of winter wheat, after passing through the thermostage and photostage, may effect all the remaining stages of development up to the ripening of seed in southern latitudes under condition of short day.

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[1] In Bengal experiments in growing cotton in the lateritic areas are in progress. The capacity of these soils for retaining moisture is very small, and after November this soil becomes very dry and hard. Cotton growing in these areas can only be profitable if the first pick can be had within about a month of the cessation of the monsoon. The Russian experiments which resulted in a high yield of first pick before the onset of frost may point out the way for modification in agricultural practices which will result in higher yield before the onset of drought.

RECENT DEVELOPMENTS IN RUSSIAN PLANT INDUSTRY

In contrast with winter wheat, we have another type of plants like millet, soyabean, maize etc., which are called short day plants. The older idea was that these plants can only mature if they are exposed every day to alternate periods of light and darkness of almost the same duration. Russian experiments have shown that these plants require, for this developmental stage that is peculiarly sensitive to light, continuous darkness and not an alternation of light and darkness. In many cases, a short day plant can, at this stage, tolerate a certain alternation of light and darkness, provided that the light periods are not too long. A discovery of great practical value consists in the observation that seeds of short day plants, if kept in darkness for about 15 days after they have just begun to germinate, can be induced to pass through their photostage even before they are actually sown in the earth. They can achieve all their subsequent development under long day summer of northern latitudes at temperatures between 15°-20°. Thus, many short day cereals, the cultivation of which in the north of Russia was unthinkable a few years ago, are now grown even in the Arctic Zone.

A parallel line of investigation has for its object the shortening of the vegetative cycle in the life of a plant between germination and ripening of seed. When cuttings were taken from a soyabean plant at successive points along the stem, the plants grown out of these cuttings behaved differently. Those from cuttings taken from above the point of insertion of the first flowering shoot all came into flower very quickly, whereas those from below the first flowering shoot were very much delayed in flowering; and the delay was greater according to the distance below the flowering shoot at which the cutting was taken. In other words, "in the life of the plant and its individual organs, there is a gradual completion of those changes which constitute the different developmental stages in such a way that the changes are most nearly complete in the youngest tissue. From this it is argued that these changes occur only in the cells of the growing point. Once the changes have occurred in the growing point, they are transmitted to all cells formed later from the growing point, so that different parts of the plant are at different stages of preparation for reproduction." By pursuing these experiments, soyabean plants have been grown in the continuous summer light of the Arctic Zone, which have shown accelerated flower formation, the first bud quite often appearing in the axil of the first leaf.

No less remarkable results have been obtained with potato. The present cultivated varieties in Eurasia have been derived from a few cultivated types brought from their original home in Peru and Bolivia. The Russian Institute of Plant Breeding wanted to give a better scope to the plant breeder by securing for him a wider choice of material. Some years ago a Russian expedition was sent to the Andes to collect specimens of both wild and cultivated potatoes from these regions. Quicker results can be obtained in plant breeding if three or four generations can be grown in one year. This result has been obtained in the wheat by correct pretreatment of seed. In the case of potatoes, it has been found that if the tubers are kept at 1°-3° for some time in a covered box where there is abundant moisture, and then sprouted on wet filter paper in the green-house at 15°-20°, the shoots immediately formed flowers when only a few inches in length. Studies are in progress with the object of obtaining flower direct from the tuber without the usual vegetative cycle. The Polar Division of Plant Industry at Hibny have discovered that, contrary to current opinion, the vast majority of potatoes are long day plants when grown at temperatures between 15°-20°, and yields have been obtained in the Arctic Zone which are regularly higher than those from Odessa and Caucasus. This conjunction of breeding and vernalization offers great possibilities for the development of the vast inhospitable regions of the Eurasian continent bordering on the Arctic Zone. A mighty nation, awakened by a new concept of world order, have mobilized their scientific resources to this end, and victory appears to be already in sight.

Use of Isotopes as Indicators in Biological Research

August Krogh

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[We print below a lecture by Prof. Krogh of Copenhagen given at the Harvard Tercentenary Conferences of Arts and Sciences in September 1936. One of the outstanding problems of biological research is to follow the processes by which living plant and animal tissues synthesize the various organic compounds from the nutritive material which are supplied to them, and how these compounds are distributed through the whole body subsequently. The problem of following up is much simplified if in the nutritive material either heavy hydrogen or radioactive isotopes of other elements are built in. The tissues can subsequently be examined for the presence of these isotopes by very sensitive methods. Prof. Krogh gives a very interesting account of this new line of research which has been made possible by the pioneer work of Hevesy.—*Editor*.]

WHILE it is undoubtedly true that the chief tool and weapon in research is thought and ideas and that a large amount of experimental work in biology is more or less wasted for lack of thought, it is not less true that progress depends to a very large extent upon methods and that new methods may open up new and fruitful fields.

It is my task to-day to present some thoughts about a new and, as I believe, extremely powerful tool for biological and biochemical research: a small number of isotopes which can be readily distinguished and quantitatively determined by relatively simple physical means.

How Isotopes simplify Research

Isotopes are atomic species which differ in weight but have the same nuclear charge and as a consequence of this last named property they are practically identical chemically and will behave in the same way in organisms. Isotopes of lead are available in nature which can be recognized and quantitatively determined physically by their radioactivity, and recent progress is making available radioactive isotopes of a number of elements including some of those which are of special importance in living organisms.

The methods for recognizing and estimating radioactive substances are highly developed and easy of application, and minute amounts are sufficient for quantitative estimation.

Early Work

Hevesy, himself a pioneer in the chemical and physical study of isotopes, was the first to see the possibilities offered in biology by recognizable isotopes and made the classical and fundamental experiments with radioactive lead in 1921.

Attempts over several years to separate radium D from lead by chemical means had thoroughly convinced him of their identity, but the atoms of the one carried a label, so to speak, in their radioactivity. When a plant is grown in a solution containing lead, this element will enter the roots and become distributed all through the plant where it can be detected chemically and determined quantitatively in the ash of stems, leaves, fruits and so on. If after a certain time the plant is transferred to an ordinary nutritive solution containing no lead, the quantity once taken up is retained and one would assume it to be firmly combined. If a radioactive variety of lead is used the detection and estimation becomes greatly simplified, but the really important point is brought out when a plant is grown first in a solution containing rodioactive lead, until equilibrium is reached, and then transferred to a solution with the same concentration of ordinary lead and it is found that the radioactive atoms gradually leave the plant and are regularly exchanged with the ordinary variety, that in other words lead atoms are in reality never fixed anywhere, but are always on the move up and down the plant to and from the single cells, to and from the organic lead compounds which are continually formed and reformed. This concept of the lability of compounds and mobility of atoms within the living organism is fundamental and it has been broadened and deepened by all subsequent research. It turns out in this particular case that lead atoms in organic combination within a plant can also be exchanged to some extent with other heavy metals, especially copper.

Radioactive Phosphorus and its Circulation in the System

Lead is a decidedly foreign substance within an organism, and it might be thought that elements which were normal constituents of the tissues would settle down more permanently. Preparing a radioactive phosphorus isotope from ordinary sulphur Hevesy and his associates have ultilized this substance for a number of experiments both on plants and animals which are still in progress. Professor Hevesy has kindly allowed me to mention some of his results. On plants the results correspond closely to those obtained with lead; phosphorus atoms will travel constantly throughout the plant and be transferred during growth from old leaves to new and vice versa, showing much more extensive transports of substances from leaves to roots as well as from roots to leaves than hitherto assumed.

On animals it is found, and was perhaps to be expected, that phosphorus introduced by injection is almost at once distributed with the blood all over the body and is excreted through the kidneys and also to some extent through the gut. In one experiment on a human subject 20.3 p. c. of the radioactive phosphorus introduced was eliminated in 4 days through the kidneys and 2.5 p.c. through the gut. When in another experiment the phosphorus was taken by mouth 15.5 p. c. was eliminated through the gut and 17.9 through the kidneys, showing that quite an appreciable amount had not become absorbed.

Most of the radioactive phosphorus introduced into a mammal leaves the blood within a short time exchanging with the phosphorus of the tissues. The exchange with the anorganic phosphorus is almost instantaneous, but also the organic phosphorus present in muscles and other organs comes gradually into an exchange equilibrium with the radioactive elements.

To my mind the most interesting result is the extensive exchange taking place in bones and teeth. It is, of course, well known that the organism is able to draw upon the seeletal system as a reserve of inorganic salts, but even remembering this I have never before been able to look upon the atoms deposited in practically insoluble salts and at a considerable distance from any blood vessels, in the dentine for instance, as being in constant interchange with the atoms of the salts in solution in tissue fluids and blood. This is, however, what the experiments clearly indicate. When a single dose of radioactive phosphorus is given to an adult rat and the animal is killed after one week 29 p.c. of the dose is found in the bones, 0.2 p.c. in the molars, 3.3 p.c. in the incisors (which are growing all the time) and 3.2 p.c. in the liver. When the rat is allowed to live on for one or two weeks more the content of radioactive phosphorus (corrected of course for the regular decrease in activity) gradually decreases, because replaced by the ordinary phosphorus of the diet. This decrease is conspicuous in the bones and in the liver, but has not so far been observed in the teeth where the exchange is much slower. When the long incisors are cut in pieces and the growing roots, a middle portion and the tips, which one would expect to be quite outside any circulation, are examined separately it is found that even here the radioactive phosphorus penetrates and an exchange takes place. So far it has not been possible to examine the enamel separately and it is a matter for conjecture whether or not this, the hardest of all tissues, is taking part in the processes of exchange.

In young rats the exchange takes place more quickly, as one would expect, and relatively more is taken up by the growing bones and teeth, but on the whole the same relations are observed.

Use of Heavy Hydrogen

The heavy hydrogen isotope, called deuterium to distinguish it conveniently from the ordinary hydrogen or protium, is as an isotope in a class by itself. On account of the 100 p.c. difference in atomic weight and the fact that D and H may be present and act as naked nuclei, its chemical behaviour is not exactly the same as that of protium. Several reactions carried out with deuterium are definitely slower than the corresponding ones with protium. The rate of hydrogenation of fats with deuterium gas for instance is only about half the rate for protium. The equilibrium constant of numerous reactions in which deuterium participates is markedly different from that obtained with protium.

Several vital processes are slowed down by heavy water, deuterium oxide, and in high concentration it is harmful or even lethal to many organisms. With this aspect of the problem I do not propose to deal. The observations go to show that in concentrations below 10 p.c., where the deuterium is mainly present as DHO, heavy water behaves in the organism just as ordinary water and can safely be used as an indicator. Deuterium can be estimated with great accuracy as "heavy water" in mixtures with ordinary water by specific gravity determinations and the chief difficulty is to purify the sample so that it contains only water. For the specific gravity determination itself, fairly simple methods are avalaible which are accurate to the 6th decimal place corresponding to 0.001 p.c. heavy water in samples containing from 0 to 5 p.c. over and above the 0.05 p.c. present in all natural waters. The falling drop method of Barbour can attain this accuracy.

Heavy water can be utilized in the study of a variety of biological problems. It was shown by Hevesy and Hofer that D_2O either taken by mouth or, in aquatic animals, diffusing in through the integuments and gills is rapidly and evenly distributed all over the body so that the concentration in the urine measures exactly the concentration in all the water in the body. We have attempted in collaboration with Hevesy to use D_2O to measure permeability, and important informations can be gained, but there is a difinite limitation to its use. It can show whether a membrane is permeable to water or not. In the eggs of certain fishes, notably the trout, there is a stage in which the vitelline membrane is stated to be impermeable to water. We have confirmed and extended this statement by means of D_2O. Immediately after laying, trout eggs swell by taking up water. Heavy water will penetrate at a rapidly decreasing rate, and after a couple of hours the penetration ceases. When at this stage trout eggs are transferred to a heavy water solution not a trace of D_2O is found, even after a day or more, in the water to be distilled off from the eggs after they have been washed superficially with ordinary water. At a much later time, when the development of the embryo has reached the stage just visible to eyes, the membrane again becomes permeable so that water can pass in osmotically and, as no swelling is observed, excretion of water must be taking place. In all cases where it is desirable to find out qualitatively whether or not water can penetrate a membrane the heavy water can be used as an indicator of very high sensitivity.

Selective Permeability for Water

In experiments on frogs we have been able to solve the much debated problem whether or not there is a selective permeability for water in one direction. When the legs of a frog are immersed in a known volume of, say 3 p.c. D_2O, the rate at which D_2O diffuses in can be ascertained and compared with the rate at which it diffuses out, observed when a frog is saturated with 3 p.c. D_2O and the legs immersed in H_2O. All the experiments made go to show that there is no significant difference in the diffusion rates outside in or inside out.

The diffusion rates measured with heavy water on living membranes are of a very low order compared, for instance, with collodium membranes, but unfortunately the heavy water cannot be used to measure the rate at which water passes through a membrane by osmotic pressure differences. It is tempting to assume that a certain concentration gradient, say of one mole per litre of D_2O, can cause the same movement of D_2O molecules across a given membrane as the water movement brought about by a pressure difference of one mole of a substance which cannot pass the membrane, but Jacobs has pointed out that the conditions are not comparable and it is certain that in the cases examined by us, mainly on frog's skin and on artificial membranes, the rates are very different and the osmotic water transport for a given pressure difference generally larger, while the proportion varies from one membrane to another.

Deuterium Indicator in Organic Metabolism

A very large and, as I believe, very fruitful field of research is opened up by the observation that an exchange will take place between the deuterium atoms of heavy water and certain protium atoms of organic substances.

If a definite amount of an organic substance, a protein say, is dissolved in a suitable amount of water with a known content of D_2O and the water thereupon distilled off the D_2O content is found to be reduced, and when the dry residue is burnt and the water formed by combustion from the hydrogen in the protein molecule is also tested the missing D_2O is found there.

At least with dilute solutions there is a difinite relation between the D_2O percentage of the combustion water and the D_2O content of the water with which the protein was in equilibrium. For albumin we have found that the D_2O content of the combustion water is 40 p.c of the distillate, and we take this to mean that 40 p.c. of the hydrogen atoms in the protein are in a labile state which allows them to continually change places with the hydrogen atoms of the surrounding water.

The experiments of Bonhoeffer and others have shown that hydrogen atoms directly attached to the carbon chain or ring are generally not liable to exchange, while the hydrogen of organic acids, hydroxyl, amino and aldehyde groups are readily exchangeable. In certain cases conditions are more complicated, as in the enol form of acetone or in maleic acid, where one or two hydrogen atoms are readily exchangeable to the outside, while a slow exchange can take place within the molecule between this and all other hydrogen atoms. In suitable conditions all the hydrogen atoms can therefore be exchanged with deuterium.

In a recent paper by Münzberg this slow exchange was specially studied on pyrogallic acid with the result that the exchange in 3 hydroxyl groups was practically instantaneous. One of the D atoms thus introduced could change places with one of the fixed H atoms by a keto rearrangement taking place at intervals, and this again could change places further by a spontaneous change in the place of the double bond, occurring at very long intervals. The final result was that all the 6 hydrogen atoms could be exchanged, but at ordinary temperatures this would take years.

It is possible to utilize compounds in which deuterium atoms have been built into stable positions and also the exchange processes themselves for the solution of important biochemical problems.

Schoenheimer and Rittenberg are working along the first of these lines. By the well known process of hydrogenation they have built deuterium atoms into linocic acid and fed the deuterium containing fat to mice. They expected to find that small amounts of fat given to animals on an insufficient diet would be readily oxidized, but they did find that even in these circumstances most of the fat was deposited before being utilized. When the fat is broken down in the body the deuterium is set free as heavy water which will become uniformly distributed in the body. In rats and mice in which the D_2O concentration was kept approximately constant over a period of a week or 10 days we (Ussing and Krogh) found small amounts of D in the body fats, indicating a new formation of fat from carbohydrate, a formation which it should be possible to measure quantitatively when the relative proportion of deuterium in carbohydrate and in fat formed from it can be determined. Schoenheimer and Rittenberg have also recently solved the long debated problem of desaturation of fatty acids as a normal process in the living organism by showing that when saturated fatty acids containing deuterium were fed to mice, and the body fats extracted after a suitable period and fractionated so as to separate saturated and desaturated acids, an appreciable proportion of the deuterium was found in the desaturated fraction.

THE USE OF ISOTOPES AS INDICATORS IN BIOLOGICAL RESEARCH

Schoenheimer and Rittenberg have pointed out the great possibilities for studying intermediary metabolism opened by introducing into the body substances suspected of being links in the chain of conversion and having these "labelled" with deuterium in a stable position. When this D is afterwards found in the normal end product of the series at least the possibility of the conversion in the body is proved. They have applied the procedure in the cholesterol-coprosterol series with very promising results and I am convinced that they have hit upon a principle of very general applicability. I expect that in a not too distant future a series of organic substances containing D atoms in suitable stable positions will become available commercially.

In my laboratory Ussing and myself, in regular consultation with Hevesy, have made a number of preliminary experiments along the second line indicated. We exposed organisms to definite concentrations of D_2O to study the exchange between the water and tissue substances. We hoped to be able to distinguish between a more or less permanent uptake of deuterium by new formation of tissue elements and a simple exchange, of the same type as that observed in vitro, but possibly different in amount owing to essential differences in constitution between proteins as isolated and proteins built into living systems.

Our first experiment was done on four equal lots of peas which were soaked in water containing D_2O and then allowed to sprout in the dark for different lengths of time up to 10 days. Contrary to our expectation the maximum of deuterium in the dry substance was found just after soaking when deuterium was present in the dry substance corresponding to an exchange percentage of 26. Later on about 20 p. c. were found so that apparently at least, no building in of deuterium into stable positions took place.

Frogs were saturated with about 1.2 p. c. D_2O which is accomplished simply be keeping a small amount of water with an appropriate percentage circulating about them for several days. One frog was killed and analyzed while exposed in this way, and another transferred to a small volume of ordinary water bringing the concentration down to approximately 0·4 p. c.. In both cases the percentage saturation of the combustion water corresponded to 30 p. c. showing, apparently, that we have to do, at least in the main, with a simple reversible exchange.

In a series of experiments on rats and mice kept in a cage in a sealed metabolism chamber and maintained for varying lengths of time at an approximately constant concentration of D_2O in their body fluids the deuterium concentrations in single dry organs were measured and compared with the concentrations in the distillates from them, which were always identical for the whole body. In most organs a regular exchange took place, so that an approximate equilibrium in the neighbourhood of 50 p. c. was reached within a few days, but the muscles behaved differently. In the first experiments which lasted a week or more, the deuterium concentration reached very high figures of about 70 p. c., but the increase was very slow as shown in a one day experiment on a rat in which the muscles had reached only 19 p. c. when the liver was 47. An experiment on three mice is especially instructive. These mice were brought by injection to about the same concentration of D_2O and kept together in the same metabolism chamber. One was killed after 1 day and showed in the proteins of muscle and bone an exchange of 11 p. c. while in the internal organs it had reached 20 p. c.. The second mouse was killed after 4 days when the percentage saturation in the muscle and bones was 25 p. c. and in the internal organs 37. The remaining mouse was now given ordinary water to drink which in 5 days reduced the concentration of D_2O in the body fluids from about 2 to about 1 p. c. The deuterium content in the proteins of the internal organs went down very nearly in the same proportion, showing now a 40 p. c. concentration, but in the muscle (and bone) the absolute content of D went up further, raising the proportion to 76 p. c.

It seems out of the question that a breakdown and reconstruction of muscular tissue should proceed at anything like this rate, and we are reminded of the slow exchange taking place within molecules referred to above. An exchange of this type might in the living organism be correlated with the activity and to test this suspicion the following experiment were made on frogs with a suitable concentration of D_2O, in which one leg was denervated while the other was stimulated to twitches at 2-3 seconds intervals over 24 hours. We found an exchange of about 9 p.c. in the leg kept quiet and 12 p.c. in the leg which had performed about 36000 twitches with an aggregate duration of less than 30 minutes.

It cannot be sufficiently emphasized that the experiments so far made are preliminary and tentative. At the same time it seems to me that the general lability of substances and tissues in the organism already revealed is of very great significance and that we may look forward to important developments.

With regard to the utilization of heavy water as an indicator we are strongly in need of a comprehensive study of the exchange in protein substances in vitro both static and dynamic, studying the influence of conditions like pH, temperature, salts and so on on the final equilibrium and the rate at which it is approached.

Limitations to the Use of Deuterium as Indicators

There are I believe great possibilities for the further use of the hydrogen isotope in biology, but it must be admitted that the somewhat cumbersome technique of purification and determination of the deuterium oxide is in the way of rapid progress along this line.

From this great country with its enormous resources we may perhaps even look forward to the separation of other biologically important isotopes which can be determined by specific gravity methods. Still I think that the radioactive isotopes are likely to become of paramount importance because the determination is comparatively easy and the activity remains unaffected by any chemical treatment including burning.

The radioactive isotopes to be used in biology must possess a fairly strong activity which generally means a short radioactive life. On the other hand the life, as characterized by the time of reduction of the activity to one half can easily become too short for biological or even chemical purposes.

A large number of isotopes have been prepared with half periods between a fraction of a second to a few hours. These will not as a rule be available for biological research.

The half period of radioactive lead is 16 years and of phosphorus 16 days which is very convenient for our purposes. A radioactive sulphur can be generated having a half period of 60 days and reports are presented of carbon with a somewhat similar length of life.

I am exceptionally fortunate in having become associated with Professor Hevesy and through him also with Bohr. The study of radioactive isotopes is to be pushed forward in Copenhagen and a powerful plant is being erected for their generation. We are determined to do the best we can, but we cordially invite both competition, co-operation and criticism.*

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* Printed with the kind permission of the Director of the Harvard Tercentenary Celebration.

Some Chemical Aspects of Sexual Development

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THE study of sexual development has recently acquired a new and vivid interest as the result of investigations on the isolation and characterization of certain distinct chemical entities from the sex-glands themselves, as well as from some other more indirect sources.

We may, for the proper understanding of the subject, first consider some of the structural and functional changes associated with the disease, disfunction, or removal of the main generative organs—the testis in the male or the ovary in the female.

This brings us to the problem of castration or sterilization about which we are hearing a good deal nowadays. Castration of animals has been resorted to in practically all agricultural countries from very early times, and the castration of man has also been practised and the results observed from time immemorial. In some countries this has been done out of religious beliefs, *e. g.* among a Russian religious sect called the "Skoptzs," and also under the Church of Rome as late as 1870 in order to conserve the high-pitched singing voices of the boys of a famous choir. Careful recent observation has shown that pre-puberal castration leads to an underdevelopment of the seminal vesicles, prostrate, and the external genitals. There is no development of hair on the face, there is accumulation of fat in the gluteal region, under the breast, in the abdominal wall, and on the face. The growth of the long bones is continued beyond the usual time, giving a great height. The voice is like that of a child or of a woman. The intelligence is not affected, but there is a certain apathy and sometimes nervous disturbance.

Post-puberal castration may lead even in more or less well-developed individuals to an almost complete disappearance of the beard, to the deposition of fat, to the absence of the sexual libido, and the power of sexual union. This led Lichtenstein, as early as 1916, to indicate the desirability of castration in sexual criminals.

Post-puberal castration in women, on account of disease or on other grounds, does not give uniform results. Generally, there is an atrophy of the genital organs, of the uterus, the shortage of menstrual flow, accumulation of fat due to diminished oxygen intake, and some growth of hair on the face. There also appear certain nervous disturbances, but the intelligence is not affected. There is a voluminous literature on the study of the effect of castration in male and female animals, birds, and insects, and one is shocked at the apparently light-hearted manner in which animals have been killed or maimed for experimental purposes in order to find out exactly the relation between the sex-glands and other endocrene organs—the pituitary, the thyroid, the adrenals, etc.—on the one hand, and the morphology, physiology and psychology of man and other animals on the other. It is concluded that not only the genital organs but the entire sex-character (primary and secondary) are influenced by the sex-glands which initiate and stimulate these characters and keep them in a state of maximum development.

It was believed at one time that castration leads to the appearance of the opposite sex, but it is now generally agreed that the castrate approaches a common, neutral, asexual child-type not peculiar to either sex.

In order to understand better what exact portion of the sex apparatus is responsible for the developement of sex-character, many experiments on complete, unilateral, and bilateral castrations and on the transplantation of the gonads into the castrate have been carried out on men and animals of most varied types. Similarly, a large number of investigations have been made on the effect of feeding of gonadal tissues and of the injection of their active extracts into partial and complete castrates. A surprisingly large number of successful beneficial transplantations have been reported by Lichtenstein, Steinach, and more recently by Voronoff. These experiments have clearly brought out the importance of the internal secretions of the sex-glands in producing and maintaining sex-characters and the independence of these changes of any nervous reflex starting in these glands. A successful testicular graft on a male castrate brings back the sex-characters lost or modified and also revives sexual desire and sexual activity. It also produces a reappearance of the hair on the face, the disappearance of accumulated fat and a change in the voice. Even old and senile men and animals have been treated with beneficial results. These improvements, however, do not persist indefinitely, but only so long as the graft remains functional in producing the chemical bodies or hormones to which their actions are due.

Ovarian transplantations have also been made, resulting in the prevention of the atrophy of the genitals, uterus, and mammary glands, in the return of menstruation and other compensatory changes in the female castrate. Even in the male it has led to a development of fat under the breast and a general feminization. In this respect the ovary acts as the antithesis of the testis.

Feeding experiments with sex-glands have not led to uniformly useful results, and the same remark applies to the injection of aqueous and glycerine extracts of the organs. The latter practice is complicated by the fact that water or dilute glycerine extracts also the proteins from the glands, and these, as is well known, produce anaphylaxis or protein-shock. Under favourable conditions, however, some very satisfactory results have been reported in birds and mammals by Pezard, Steinach and others. These and other experiments not only demonstrated the presence of actual hormones of a purely chemical nature in the glands but also emphasized the importance of some other endocrine organs in the maintenance of sex-character. But whereas the expiration, disfunction, or disease of the other endocrine organs lead generally to marked and widespread pathological changes in the organism curable only by transplantation or injection of extract of the glands concerned, similar extirpation of the sex-glands does not lead to widespread morbid changes but only to structural and functional alterations associated directly with the generative process. The ovary and the testis have, therefore, a specific sexual effect—*femaleness depending on the ovary and maleness on the testis.*

A great deal of controversy and a host of experiments on animals and men have now clearly established the fact that, whereas the seminiferous tubules with their ducts are concerned with the elaboration of the component of the semen and specially of the spermatozoa, they play practically no part in producing the sex-specific hormone or hormones. Similarly, the formation and maturation of the ovum are due to changes that take place in the graafian follicle. These parts of the gonadal tissues have, therefore, mainly a generative function. The formation of the hormones actually takes place in the interstitial cells of the testis or the ovary. This explains why, even when spermatogenesis is brought to an end by the ligature of the vas deferens, by disease (like tuberculosis), by the action of X-rays, or by chronic alcoholism, there are no signs of castration in the male. On the contrary, there may arise a hypertrophy of the interstitial cells under these conditions, leading to an intensification of the sexual impulse. This fact has been taken advantage of by Thorek in restoring potency in an ape, previously castrated, by engrafting a human cryptorchic testicle (in which spermatogenesis had not yet been established). Experiments by Steinach with transplanted testicles (in which the seminiferous tubules generally atrophy and are unfunctional) fully corroborate the view that the degree of development of the sex-characters depend on the degree of development of the interstitial tissue. Experiments with X-rays support this view. These rays have selective action in the tubules, and one or more applications may cause complete sterility without interfering with sexual activity, because the interstitial cells are unharmed. This specific action of the tissue has acquired for it the name 'puberty gland'. It is interesting to know that there are two distinct climaxes in the sexual maturity in the male, one taking place at a certain stage of embryonic development and the second one at the time known as puberty. Both these climaxes refer to the interstitial tissue, but the second climax synchronizes with a rapid growth of the generative part of the gland in the seminiferous tubules. By an interplay of these two specialized portions of the gland there arises at the onset of spermatogenesis a full functional development in the interstitial tissue as well.

In the female the follicle is the endocrine apparatus of the ovary, but the ovum itself is not necessary for the production of the hormone. In the female there is not that clear differentiation of the generative from the secretory tissue, which we find in the male. The rapidly proliferating epithelial cells of the follicle take up this function after the liberation of the ovum, and the corpus luteum so formed go on secreting the hormone till the time is ripe for the next ovulation. Besides the corpus there are in the ovary, before puberty, epitheloid cells with fatty lutein-like inclusions, which increase in number till puberty and attain their greatest development during pregnancy. These become atrophied at climacteric and correspond to the interstitial tissue in the testis. The action of X-ray on the ovary is also confined to the generative part, the interstitial cells undergoing hypertrophy. No signs of castration, therefore, follow irradiation, but there is a marked development of the uterus and the mammary gland.

Many experiments on the grafting of ovaries on the male and female animals of the same or different species have shown that such a process has a distinct feminizing effect, just as the grafting of the testis produces masculinization. All these facts prove that the interstitial cells derived from the follicles of the ovary also elaborate a sex-specific hormone in the female.

Brown-Sequard was the first biologist to try the effect of the injection of the extract of the testis into a man (in this case, himself) when he was about 72 years old (1889) and described the beneficial results on the mental and physical capacities. These results are now regarded as being due to psychological rather than biological causes, as the method of extraction adopted by him would not appear to have been very effective. Indeed, so long as the extracts were made with water or physiological saline, the results were variable, but on replacing this solvent by alcohol, ether, and specially chloroform, more consistent results were obtained. Fellner and Hermann in this way obtained extracts of placenta, ovaries, corpora lutea and of non-pregnant uterus. They found the extract active in producing hyperaemia and muscular thickening in the uterus, increased growth of the mammary glands and of the nipples. On the castrated animals also these extracts proved very active and made the signs of castration disappear quickly. Testicular extracts were also found to promote uterine and mammary development, so that the female hormone may be present in lesser quantities in the male. On the other hand, ovarian extracts were found to have an inhibiting action on the testicle. This shows there are in these extracts not one but more substances, each with a specific action of its own.

The presence of an oestrus-producing (heat-producing) hormone in the urine of pregnant women was first shown in 1927 by Acheim and Zondek. In 1929 several workers isolated the female hormone in a crystalline condition. Thus, Butenandt purified and analyzed it and studied many of its chemical reactions. He showed it to have an m. p. of 243°C and to possess one OH, one CO group and three double bonds with a molecular formula of $C_{18}H_{22}O_2$. This was independently isolated and crystallized by Marrian from the same source together with another crystalline substance (m. p. 281°C, molecular formula $C_{18}H_{24}O_3$ with 3 OH groups, of which one was phenolic in nature). Both these substances could be repeatedly crystallized without loss of their activity. The second compound could be transformed into the first by dehydration. The first was called the follicular hormone (dioxy-oestrin) and the second substance trioxy-oestrin). The activity of the first is greater than that of the second.

SOME CHEMICAL ASPECTS OF SEXUAL DEVELOPMENT

In addition to the hormone the authors isolated from the urine of pregnancy another physiologically inactive crystalline compound called pregnandiol ($C_{21}H_{36}O_2$) which was a saturated compound and on oxidation gave a diketone (pregnandione), which on reduction gave pregnane, the mother substance of the whole group of compounds. A derivative of this was proved by Butenandt to be indentical with an oxidation product of a bile acid, and thus the sex hormone group was brought into relation with this important group of known complex compounds and a probable source of the hormones was indicated. These compounds are, however, not present in male urine or non-pregnant female urine or in the urine of mares. A large number of oestrogenic substances have been discovered in recent years. Equilin prepared from the urine of pregnant mares has the empirical formula $C_{18}H_{20}O_2$ which has two hydrogen atoms less than oestrone. Recent work of David and de Jong has shown that "equilin compared with oestrone in equivalent dosage was more active in producing oestrus in the castrated rat, uterine and to some extent vaginal growth, vaginal opening in the young female rat inhibition of the testis and the male secondary organs of the male rat and stimulation of the mammary gland of the guinea pig."

Further work on the chemical reactions of these substances together with a study of the X-ray crystallographic measurements and other physical data have enabled the authors to give very plausible formulae to these derivatives.

A male sex hormone has also been obtained in a crystalline state by Butenandt (1933) from the male urine. This is related to the follicular hormone. It is a saturated hydroxy ketone with no acidic properties, has an m. p. 178°C and has a formula $C_{19}H_{30}O_2$. A structural formula was also tentatively suggested. Its activity was found to be of a high order, since a total quantity of $1\text{-}1{\cdot}2 \times 10^{-6}$ gm administered in 4 doses in the course of two days produces a 30-35% increase in the growth of the comb in cocks.

It is believed that the sex-hormones are the oxidation products of the bile acids or the sterols (*e.g.* cholesterol, which is present in brain and nervous tissues and in various parts of the body) by the break-down of the side-chains and partial dehydrogenation and loss of a methyl group. Marrian has also isolated from the pregnant mares' urine a crystalline derivative $C_{15}H_{12}O\,(OH)_2$, m. p. 189-190°C, with a phenolic character which he called equal. This is inactive. Girard similarly isolated from the same source not only a hormone but also some other isomeric crystalline substances with reduced activity. The mutual relationship of the male and female hormones and also their probable origin from the sterol or bile acid group of compounds was brilliantly established by the extensive researches of Ruzicka, who actually prepared androsterone (the male sex-hormone of Butenandt) from a cholesterol derivative (1933).

A crystalline corpus luteum hormone ($C_{20}H_{30}O_2$), m. p. 128°C, has been isolated and studied by four groups of workers: Butenandt, Slolta, Hartmann and Allen with their coworkers, and has been shown to be an unsaturated diketone.

As the result of pharmacological studies in Amsterdam by David, Freud and de Jong, it is concluded that the sex-hormones are not sex-specific and that they do not affect whole organs but only certain tissues. In the sex-organs oestrone is a growth promoter to the smooth muscles, stratified epithelium, as also some glandular epithelium, and also counteract the noxious effects of oestrin.

Extensive studies are being made in the Lister Institute, London, in Paris and in several places in Germany to find out the methods of assaying and standardizing the various hormone preperations and the effect of their injections either singly or in combination into the male and female animals.

Korenchevsky, Dennison and Brovsin have published the results of extensive investigations on the biological properties of synthetic testesterone (a hormone isolated from the testis), the co-operative effect of this hormone with oestrone and oestradiol, and the comparative effects of androsterone, andresterone-diol and testesterone. A short summary of the investigation would give an indication of type of the experiments that are being performed and the nature of the results generally obtained.

When compared with control specimens, it was found that injection of 1 milligram of testesterone to normal male rats increased the weight of seminal vesicles by 770%, of prostrate by 300%, of penis by 150%, of preputial glands by 135%. In the case of rats castrated 51 days before the experiments started, prolonged periods of injection (25 days) in doses up to 1 milligram failed to restore the normal weight of the atrophied sexual organs. Injection of oestradiol brought about changes in the atrophied organs similar to those obtained after injection of oestrone, increase in the weight of seminal vesicles up to 150%, small increases in the weight of the prostrate and preputial glands, the penis remaining unchanged. In ovariectomized female rats, there was marked co-operative effort between testesterone and oestrone in restoring atrophied sexual organs to normal weight. The male hormones testesterone, androsterone and androsterone-diol have some of the important properties of the female hormone, so that if they are present in the female organism, they co-operate with oestrone in controlling the condition and function of the sexual organs in the female. Intensive research is also directed towards elucidating the constitution of the hormones and hormone-like substances from various plant and animal sources with a view to their ultimate large-scale preparation in the laboratory. When these researches have borne their fruits and a more precise knowledge has been acquired regarding their action in the organism and regarding their mode of formation in the body, we shall no doubt come nearer to the object of man's eternal quest—rejuvenation and perpetual youth.

Relativity on Trial

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Relativity Postulates

We know that light has a finite velocity of about 186,000 miles (300,000 kilometres) per second, and the velocity of the earth in its orbit, which is about 19 miles per second, is not altogether negligible compared to it. Owing to the motion of the earth, in its orbit, the positions of the stars at different times of the solar year appear to be shifted. This aberration effect is the necessary result of the compounding of the velocity of light with that of the earth. Again, the motion of the earth away from, or towards, a heavenly body produces the well-known Döppler effect, which also is the result of the relative motion of the source of light and the earth. In spite of these well-known phenomena, which are but manifestations of the differnce in the velocity of light relative to the observer, Einstein, in order to explain the Michelson-Morley and allied experiments, made the bold but apparently incomprehensible assumption that the velocity of light, though finite, is yet absolute and has the properties of an infinite velocity so that it is always the same relative to another body, no matter with what velocity that body may be moving. It is true that in spite of the constancy of velocity of light, the Döppler-effect can be explained from the principle of Special Relativity, but this explanation is not so direct and straight forward as the explanation obtained from compounding of velocities according to Newtonian dynamics. Thus if light were overtaking an electron moving away at 125,000 m/s., the velocity of light relative to it, as observed by an observer moving with the electron, would still be 186,000 m/s., and if an electron with the same velocity were coming towards the light, light would meet it with 186,000 m/s." A Beta particle shot off from radium can move at more than 200,000 km., but the speed of light relative to an observer travelling with it is still 300,000 km. per sec." (Eddington)[1]

Supposed Confirmations

Had it not been demonstrated that these ideas lead to certain mathematical results, like the equivalence of mass and energy, which are actually verified by observation, it is extremely doubtful whether such an extraordinary postulate could ever have been accepted by the scientific world. On the framework of ideas of space and time laid down by the Special Theory was built up the so-called General Theory which utilizes still more difficult and rather unconvincing hypotheses. But it gave to the world three rather startling predictions:—(*a*) the advance of the perihelion of mercury, (*b*) the deflection of light in the gravitational field of the sun, and the stars, and (*c*) the red shift of light from the sun and the stars, none of which could be explained from the Newton-Galileo mechanics. The first was shown by Einstein to tally with Newcomb's observations. The second was announced to have been verified by the English expeditions in 1919, and later by the American astronomers, Campbell and Trümpler in 1922. The third was announced to have been verified, as regards the spectral shift of light from the sun and also from the white dwarf companion, Sirius B, by Evershed, St John, Grebe, Bachem, and Adams. The ideas underlying the Principle of Relativity accordingly were supposed to have achieved their full triumph.

In an article published in Science & Culture[2], it was shown that the confirmation of predictions (*a*) and (*b*) has come to be doubted in the light of more modern and critical observations of Freundlich accepted by Von Gleich and other authorities. I have already in the said paper, criticized St John's so-called verification of the red shift. So long I was under the impression that I was the solitary critic, but I had a pleasant surprise to find that lately, even so acute and experienced an observer as J.

Evershed, finds himself in rather violent disagreement with the so-called verification of the third prediction by the late Dr St John. I will discuss it more fully.

The Spectral Shift

St John made most elaborate observations of the spectral shift of light from the sun in 1928 and published the mean values. An enormously large number of measurements of wavelengths from the centre were supposed to have confirmed the Relativity value. But he took comparatively fewer observations of the red shift of light from the edge of the sun. The mean value of the red shift from the edge was found to be much higher than Einstein's value. Instead of frankly admitting that the Relativity value was not proved on the limb of the sun, he preferred to attribute the limb excess to some unknown and unexplained "Edge Effect."[3]

Recently J. A. Evershed has re-examined St John's values and compared them with the values which he had obtained years ago at Kodaikanal, which he had previously hesitated to publish, and the values which he obtained recently, and felt compelled to come to the conclusion that the so-called "Edge Effect" was equal to the spectral shift itself, that is to say, the real shift as observed was double of Einstein's value, the difference thus being 100 per cent. The divergence is so remarkably wide and the margin so large that there is hardly room for any serious suggestion that it is due to an error of observation. Another important and significant fact discovered by him is that the spectral shift rapidly changes as we move from the centre of the disc to the circumference.[4]

Relativist Attitude

The whole mathematical structure of Relativity is based on certain arbitrary postulates, both startling and unconvincing. But if the postulates are once granted, then the analysis is flawless, and the mathematical super-structure is simply lofty and grand. It is the soundness of the foundation which is really open to question. The sole justification for the postulates lies in the supposed verifications of the results. If they are not confirmed, the theory must break down. Of course, repeated observations will be required before Relativists will accept such a verdict, howsoever clear it may be.

The following interesting episode has been quoted by Sir Arthur Eddington himself :

The Astronomer Royal, under whose care the equipments for both the eclipse expeditions of 1919 had been prepared, was explaining how there were three possibilities: the deflection might be equal to Newton's value, or Einstein's value, or there might be no deflection at all. When Cottingham asked what the position would be if they found a deflection of double the Einstein value, the Astronomer Royal replied, "In that case, Eddington will go mad and you will have to come home alone". (Eddington).[5] Sir Arthur Eddington has said, "I think *that still describes the situation* as far as I am concerned."

Let us quote Mr Evershed's own words :—

Dr J. Evershed : The excess shift is very nearly equal to the Einstein effect, which means that the total effect is twice the Einstein shift. I am wondering whether Sir Arthur Eddington has a factor of 2 up his sleeve to account for this remarkable result.

The President : I think that Sir Arthur Eddington should make a comment.

Sir Arthur Eddington : *I cannot help Mr Evershed.* This is a matter of relativity theory ; it is only in the quantum theory that we have factors of 2.[6]

Einstein himself admits that his General Relativity Theory rests solely on the three criteria which distinguish his theory of Gravitation from that of Newton's, and must collapse if in any of these cases it does not accord with experience. To quote his own words :—

"(i) In the revolution of the ellipses of the planetary orbits round the sun (confirmed in the case of mercury).

(ii) In the curving of light rays by the action of gravitational fields (confirmed by the English photographs of eclipses).

(iii) In a displacement of the spectral lines towards the red end of the spectrum in the case of light transmitted to us from stars of considerable magnitude.

The chief attraction of the theory lies in its logical completeness. *If a single one of the conclusions drawn from it proves wrong, it must be given up: to modify it without destroying the whole structure seems to be impossible.*" [7]

The Deflection of Light

The measurement of the deflection of light involves considerable difficulties. Two observations have to be taken, separated by an interval of about six months. Elaborate calculations have to be made for corrections necessrary to get rid of the effect of aberration due to the motions of the earth and the motion of the solar system; and also due to the refraction of light by the earth's atomosphere. Further, corrections have to be made for stars which are a little away from the edge of the sun. Again, such observations can be made only during a total solar eclipse when stars behind the Sun can be photographed. Such total eclipses occur at intervals. Unfortunately very often only stars of low magnitude happen to be behind the sun at such times and the photographs are therefore difficult and indistinct. Bright stars were behind the sun when the sun was in the Hyades in June 1919. No large stars will be behind the sun upto 1952, although no less than 7 total solar eclipses will occur in between. The last solar eclipse of 19th June, 1936, furnished a small opportunity, but it was not a very favourable one. None of the astronomers of America, Germany, England or France attempted to measure the deflection of light. Another such opportunity will occur next year on the 18th June, 1937, in Peru.

So far as is known, A. Michailov of Moscow, is the only astronomer who has taken photographs to measure the deflection. He has worked out a new method of measuring this deflection, which differs from those previously used, but has not yet published his method. He observed the total solar eclipse in the Far East when the sky was perfectly clear; but the 4 plates that he obtained for testing the Einstein effect were not quite as sharp as he would have wished. Nevertheless he hopes to get a good value for the deflection. Ordinarily, it would have been appropriate to repeat the photos in December this year for obtaining the exact star positions. But unfortunately the temperature prevailing at night in those regions in December is exceedingly low, about—40 degrees Centigrade. It is, therefore, doubtful whether the clockwork would run at all in such an intense cold, and the state of the instrument would also be quite different. He is, therefore, compelled to postpone the second exposures till about the beginning of March next year. This will involve the necessity of introducing still more intricate and complicated corrections and will also delay the publication of his results till after next Spring. Let us hope that he will be able to announce some definite results. Let us also hope that other astronomers will avail themselves of the opportunity offered by the next year's eclipse in Peru, as Einstein's value requires a severe testing.

The Spectral Shift

The measuring of the spectral shift is simpler in many ways. Astronomers are not bound to wait for a total eclipse, and observations can be made at an annular eclipse also, and in fact at any time of the year, particularly if the observation is to be for light from the centre or other parts of the disc. For observations of the spectral shift of light from the Edge, best opportunities are, of course, afforded by total or annular solar eclipses, when the light from the interior parts of the disc is excluded, avoiding the confusion caused by scattering by selecting waves of longer wavelength, refractions through the atmosphere of the earth is also considerably eliminated. Thus there would be many more occasions for measuring the red shift of light from the Edge than for measuring the deflection of light from stars. The observations do not require so many elaborate corrections, and the second observation can be repeated in the observatory without the necessity of going again to the place where the eclipse was observed. This reduces both expense and labour. But curiously very few astronomers were interested in measuring the spectral shift on the occasion of the last solar eclipse. Apparently they were engaged in collecting other spectral data.

Fortunately T. Royds of Kodaikanal Observatory, who led the deputation financed by the Government of India to Japan, was successful in obtaining some photographs of the spectral shift of light from the Edge just before totality, but owing to the darkness due to clouds gathering in the atmosphere, his observation of the light just after totality was not successful. He will take some months before his results are ready, as some time will be required for making the measures and he will have to take fresh comparison photographs. T. Royds has had a unique opportunity of taking photographs of light from the Edge of the Sun when the rest of the light was shut out. He has therefore, had greater facilities than Evershed and other previous observers, and his results will accordingly be awaited with great interest.

The New Theory

Einstein calculates the spectral shift of light by making the assumption that the radiating solar atoms are at rest, that is to say, dr, $d\theta$ and $d\Phi$ are all zero,—an obviously impossible hypothesis. According to his theory the spectral shift of light from all parts of the surface of the sun is the same, no matter whether one receives the light from the centre of the disc, from the edge of the disc, or from any other part on its surface. This result is undoubtedly contrary to the actual observations.

According to the new theory based entirely on Newtonian principles and without the postulates of Relativity, which I have published,[8] the equation of motion for a material particle as well as for a light corpuscle is identically the same—

$$\frac{d^2u}{d\theta^2}+u=\frac{\mu}{h^2}+\frac{3\mu}{D^2}u^2$$

where h stands for the areal rate and D for the velocity of gravitation equal to that of light. In Einstein's equation for light the first term on the right is missing. This difference yields results which furnish the most conclusive and decisive tests between the two rival theories.

The Predictions

(1) The solutions of the differential equation of my theory have been obtained for the maximum and minimum values of the deflection of light which should be between the minimum value 4/3 times and the maximum value 3/2 times Einstein's value, nearer the latter than the former, that is, from 33 to 50% more than Einstein's value, that is, between 2″.32 and 2″.61.

(2) While the spectral shift of light from the Centre is the same as that of Einstein's, the spectral shift of light from the Edge of the Sun is double of Einstein's value, that is, 100% more, tallying exactly with Evershed's latest observation; and

(3) what is more, the new Theory gives a formula for the spectral shift of light from any part of the surface of the Sun varying rapidly from the Centre to the Edge, and is equal to

$$\frac{\mu}{D^2 a}\left(1+\mathrm{sun}^2 a\right)$$

where a is the angle between the line of sight and the radius of the Sun, thus varying from zero to $\pi/2$ This appears to agree with the result recently obtained by Evershed for the Centre and the Limb, and for the gradual variation of the red shift from centre to limb. The observations of the spectral shift, which has most marked differences in the two theories, will furnish the final test, and furnish it soon.

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(5) *Obs.* Jan. 1932, No. 692.

(6) *Obs. 49.* No. 741, Feb. 1936, pp. 29-32.

(7) Einstein: *The World as I see it* p. 172.

(8) *Pr. Nat. Ac. Sc.*, India, *6*, Part 4, 1936. For Abstract see *Ind. Phy. Math. Jour.* *7.* No. 2 Sept., 36, pp. 57-62.

American Excavation at Chanhu-daro in Sind

A. Ghosh

WITH the discovery of Mohenjo-daro in 1922 the question of Indian prehistorics assumed a unique importance. Harappa in the Montgomery district of the Panjab was already known as a prehistoric site, and what small antiquities were recovered from this place could now be easily ascribed to the same people who had inhabited Mohenjo-daro. In order that the civilization represented at these two places could be studied in its proper perspective, it was essential to know whether there were other prehistoric sites in the neighbourhood. The late Mr R.D. Banerji, who first realized the prehistoric nature of the Mohenjo-daro mounds, collected some information about such sites. But a more thorough exploration of Sind was conducted by Mr N. G. Majumdar during the winter seasons of 1927-8, 1929-30 and 1930-1. The exploration was thoroughly successful: for not only did it result in the discovery of over twenty prehistoric sites unknown before, but, perhaps what may ultimately prove to be a fact of the greatest import in the history of the cultural, and possibly racial, movements in India, he found traces of cultures which, though prehistoric, had no affinity with the one represented at Mohenjo-daro and Harappa. At Amri in the lower Indus valley he found evidences of occupation below the Mohenjo-daro level, a sure indication of an older culture having existed there. Similarly, at Jhukar near Larkana, there were proofs of a people, still living in the Chalcolithic Age, having inhabited the place after the Mohenjo-daro people. There is thus evidence of the existence of at least three prehistoric cultures which successively thrived on the Indus valley, and the mutual connexions of which we do not know at the present state of our knowledge. The name 'Indus civilization' or 'Indus culture', which has got into vogue to designate the culture of Mohenjo-daro and Harappa, is, therefore, rather misleading. Following the accepted practice of archaeologists of naming a culture after the site where traces of it were first found, we may tentatively call these cultures the 'Amri culture', the 'Harappa culture' and the 'Jhukar culture' respectively, as has been suggested by Dr Ernest Mackay.

Each of these cultures had a characteristic pottery of its own. The pre-Harappa pottery of Amri is wheel-made with thin walls. 'The designs are painted in black or chocolate on a matt surface which bears either a thin slip, or merely a wash, of buff or light red colour. Frequently a reddish brown band is indicated, side by side with black or chocolate, which produces a polychrome effect....The vessels of this class are mostly "rimless", the predominant types being beakers and bowls'.[1] In Sind such pottery has been found at Amri, Lohri near Lake Manchhar, and some places in the hills of Western Sind. Next in order of sequence comes the Harappa type, found at Mohejo-daro, Harappa, Chanhu-daro (Nawabshah district), Ghazi Shah (Larkana district) etc. Most specimens of this class, with its thick walls, rims and splayed-out necks, are unpainted, and the shapes are very much different from the Amri type. The painted varieties that exist again show different designs and colours. 'As a rule, the designs were executed in black on a dark red slip, and consisted ordinarily of foliate and geometrical designs, among which the "interlocking circle", "vase", "bangle", "comb", and "scale" motifs are striking'[2] A later phase of the prehistoric civilization of the Indus Valley is found at Jhukar and Lomunjo-daro (Larkana district), and some other places near the Manchhar lake. Here again the pottery is distinctive : 'some parts of the design (*e. g.* balls in compartments) are shown in dark red, and red or pink wash is substituted for the slip. Moreover, new motifs were used, the most typical of them being the "sloping oval", "balls in compartments" and the "spiral".[3]

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[1] Majumdar, *Explorations in Sind*, Memoirs of the Archaeological Survey of India, No, 48, 149.

[2] Marshall, *Mohenjo-daro and the Indus Civilization*, *I*, 371.

The site of Chanhu-daro in the Nawabshah district of Sind, about 12 miles west of the present bed of the Indus, about 80 miles from Mohenjo-daro and over 400 miles from Harappa, was discovered by Mr Majumdar in 1930. There are three mounds here, the second and highest one being about 23 feet from the present ground level. The operations of Mr Majumdar, although much limited in scope, resulted in the recovery of copper implements, beads of various materials, bangle fragments, terra-cotta toys, various kinds of painted and unpainted pottery, figures of the Mother-goddess, inscribed seals etc., all of which could be definitely recognized as belonging to the Harappa culture.[4] No doubt Chanhu-daro was a promising site of the culture, all the more important because it was the only such site west of the Indus as yet known.

The American School of Indic and Iranian Studies and the Boston Museum of Fine Arts were granted a licence by the Government of India for the further excavation of Chanhu-daro. The work was started in the winter of 1935-6 with Dr Ernest Mackay as the Field Director, who has now published short accounts of the season's work[5]. The second mound, being the biggest, was at first excavated. In the uppermost stratum an unfamiliar type of grey pottery was exhumed. In the next stratum polychrome pottery, with black and red on a cream or pink slip, was found. This pottery is affiliated to the Jhukar ware, which, according to Dr Mackay, resembles in design and colour, though not in shape, the pottery found at Tell Halaf (North Assyria) and Tell Chagar Bazar (Mesopotamia). It seems that the technique of the Tell Halaf pottery reached the Indus valley through Baluchistan, a connecting link being supplied by a notable sherd of similar type found by Sir Aurel Stein at Zayak in Baluchistan.

The people of the Jhukar culture occupied the place shortly after its desertion by the people of the Harappa culture, the relics of which were found in the next two strata. Here the structural and portable remains show identity with those of the Harappa culture as known from elsewhere. Copper and bronze implements and tools, *e.g.*, axes, adzes, chisels, spear-heads, knives, daggers, and razors, as well as vessels, are of the type with which excavations at Mohenjo-daro and Harappa have made us familiar. Small masses of lead show an acquaintance of the people with that metal also[6]. Long agate, carnelian, and steatite barrel-cylinder beads were found scattered at various stages of making. It is now evident that the harder beads of agate and carnelion were bored through by means of chert drills, of which many specimens have been found, with the help of some abrasive, such as emery. In a vessel were found beads so small that 34 of them, placed side by side, go to an inch. It must have been a task of enormous difficulty to fashion and bore them.

Copper being abundant, stone had a very limited application, being used for mace-heads, drill-caps, and sometimes dishes. Kitchen-knives were made of ribbon-flakes from a core of coarse chert.

At this level was also found pottery with the characteristic Harappa painting on it, *viz.*, black on burnished red slip, a common motif being a series of intersecting circles.

A considerable number of toys found here shows that toy-making might have been a local industry. Many of the pottery figurines were designed to be fastened to little model carts, of which also some specimens exist. Figurines of the Mother-goddess have been found, often associated with little model doves with outstretched wings. It is interesting to recall that dove was intimately associated with the worship of the Mother-goddess in Crete, Sardinia and Mesopotamia.

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[3] Majumdar, *loc. cit.*, 9f.

[4] *Ibid.*, 36f.

[5] *Bulletin of the Museum of Fine Arts*, Boston, October, 1936; *Illustrated London News*, November 14 and November 21, 1936.

[6] Small masses of lead, as well as a few lead objects, have been found at Mohenjo-daro also. Lead occurs sparingly in the Pre-dynastic Period of Egypt. It was known in the Early Sumerian Period of Babylonia and has been found is some tombs of the Second Minoan Period of the Aegeon Civilization. See Partington, ***Origins and Development of Applied Chemistry***, 1936.

Steatite seals, which, taken singly, are parhaps the most characteristic thing of the Harappa culture, are present at Chanhu-daro also. The animal most commonly represented on the seals is the bull with a manger (?) in front of it. It may be noted that Professor Henri Frankfort has recently announced the discovery at Tell Agral (Mesopotamia) of a fragment of a green steatite vase with a humped bull and a manger represented on it, which he acclaims as the first discovery of the rendering of an Indian cult object in an entirely Mesopotamian setting, a fact indicating something more than intermittent contact or trade between ancient Mesopotamia and the Indus valley[7]. Another find at Chanhu-daro probably having some cult significance is a seal impression showing two women supporting between them a staff, from the top of which project the branches of *pipal* tree.

A large number of chert weights, nearly always cubical, with the simple ratios of 1, 2, 4, 8 etc., have been found. The important fact that they differ very inconsiderably from the corresponding weights of Mohenjo-daro and Harappa, the latter of which is more than 400 miles away, betrays not only an absolute identity of culture, but a strict supervision that was exercised by the authorities to maintain fair dealings in trade.

Excavations proved that, as at Mohenjo-daro, there are different levels of occupation by the people of the Harappa culture. Two such strata have been laid bare, and deep digging at one place showed that three more were still lying below till subsoil water was reached. But unlike Mohenjo-daro the levels here do not follow each other in quick succession, which shows that the city was several times deserted for considerable periods of time. There is little doubt that the desertion was due to the devastating floods of the Indus, of which there are traces of at least three. Though the Indus is now 12 miles to the west of Chanhu-daro, there is trace of an ancient river-bed only three miles away. The bricks of the buildings are of the same size as the Mohenjo-daro and Harappa ones, their size averaging 11 × 5½ × 2½ inches. Practically every house had its bath room and latrine. We also come across the elaborate drainage system and care of sanitation which is a remarkable feature of the urban centres of the Harappa culture. A number of drain-pipes of porous pottery, so designed that the tapering end of the one could be fitted into the larger end of the other, shows quite a modern ingenuity.

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[7] *Illustrated London News*, September 12, 1936, 432.

Science in Industry

Our New Feature

From this issue we are starting a new feature in our journal. We propose to publish in this section, as the name SCIENCE IN INDUSTRY indicates, scientific news and notes which are mainly of industrial interest. The application of science to industry, both on the side of technique and organization, and the problems arising therefrom will be discussed in this section by competent authorities, always with special reference to Indian conditions and with an eye on our national needs. In starting this feature we are only taking a step towards fulfilling one of the principal aims with which this journal was started, namely, the application of science to national development and economic welfare.

We publish below an article by Professor S. K. Mitra, on standardization of weights and measures, in which he has put forward a strong plea for the adoption of metric system in India. The article is very timely since the question of adopting some standard system of weights and measures for the whole of this country is engaging the attention of the government as well as the mercantile bodies. At the eighth Indian Industries Conference, Lucknow, and also at the meeting of the Associated Chamber of Commerce at Calcutta, the question was recently discussed. The latter body passed a resolution urging the Government to adopt a standard system of weights and measures. We would take this opportunity to point out the immense superiority of the metric system over other prevalent systems, as has been done in a very convincing way in the article printed below.

Previous Attempts to Standardize Weights and Measures

We give below a short review of the attempts made by the Government of India to introduce a standard system of weights and measures in India since the year 1867.

In 1867 a committee was appointed by the Government of India to deal with the question of unification of weights and measures in India. The Secretary of State in approving the terms of reference of the committee forwarded to the Government of India a report of the representations made by a deputation from the Metric Committee of the British Association on the subject of the introduction of the metric system into India. The committee appointed by the government submitted its report in 1868 and its majority recommended the adoption of the English standard of weights and measures and length. Three members of the committee Colonel Strachey, Colonel Hyde and Mr Graham, however, submitted a strong note of dissent urging the adoption of the metric system.

In 1870 the Indian Weights and Measures Act was passed (Act XI of 1870) for gradual introduction of the metric system into India. The Secretary of State, however, refused sanction to the Bill, because it was thought to be too extensive and ordered a revision of the Act.

In 1871 a new Act was passed (Act XXI of 1871) making the 'seer,' the primary standard of weight equal to one kilogramme and the volume of one seer of water (*i.e.* 1 litre) the primary standard of capacity. In order to introduce the decimal system the Act further ordained that all subsidiary units should be integral multiples of the primary standard and should be expressed in decimal parts. Lord Northbrook's Government, however, recommended that the introduction of the provisions of this Act should be subject to the consent of Railways. The Railways, on being consulted, could not come to a unanimous decision about the simultaneous adoption of the new measure of the weight, and the Act, therefore, though still in the statute book, is entirely a dead letter.

In 1875 the Government of India decided that the Indian maund of 40 seers (each seer 80 tolas) should be standard in use on the Guaranteed State Railways. (Resolution No. 21-R, dated 9th October, 1875). This is the origin of the so-called Government 'seer' of 80 tolas. Previous to this in 1870 the Indian Coinage Act (Act XXIII of 1870) defined a tola as 180 grains Troy being the weight of a rupee. The Indian Railways Act (Act IX of 1890) also adopted similar definitions of the maund and the seer.

In 1889 the Measures of Length Act was passed (Act II of 1889), in which the British Imperial Yard was made the primary standard of length for use in India.

Between 1890 and 1913 the policy followed by the Government of India had been to prescribe, as necessity arose, standard weights and measures for particular districts or groups of districts similar to those adopted by the Indian Railways and Government departments.

In 1901 the Secretary of State forwarded to the Government of India copies of a paper presented to Parliament regarding the adoption of metric system of weights and measures in European countries and suggested that the first step in India would be to accustom the public to the new weights by adopting them on Railways, at custom houses and in post offices. To this despatch the Government of India replied that though they recognized the advantages of the decimal system yet they were averse from taking any action in the matter at that time owing to serious obstacles in introducing any new measure and preferred to wait before proposing a change until the United Kingdom had decided to adopt it.

Between the years 1901 and 1913 the various provincial governments made attempts from time to time to introduce uniform system of weights and measures in their respective provinces and corresponded with the Government of India for the purpose. The Government of Bombay in particular appointed a committee in 1913 to discuss the question as far as their province was concerned. Some of the chambers of commerce and trades associations also addressed the Government of India pointing out the urgency of the reform and making various suggestions.

In 1913 the Government of India decided to reopen the question of the feasibility of securing the use of uniform weights and measures in India and appointed a committee to enquire into the whole subject.

In 1914 the Committee of Weights and Measures submitted its report. For weights they recommended the standardization of the Indian system (maund, seer, chatak), for length the British system (yard, foot, inch), for areas of agricultural land the same system (acre, etc.), for small areas the squares of any authorized measures of length and for capacity the volume of 1¼ seer of water at 80°C as the primary unit. One of the members of the Committee, Mr A. Y. G. Campbell, I.C.S., submitted a minute of dissent in which the wholesale adoption of the metric system was strongly urged.

No substantial effect has been given by the Government either to the majority report of the Committee or to the minute of dissent owing probably to the great war which broke out immediately after the publication of the report.

Countries with Metric System

Following is a list of countries where metric system of weights and measures is optional or partially compulsory:

Canada, China, Egypt, Ethiopia, Great Britain, Ireland, Irish Free State, Paraguay, Turkey and United States.

In following countries metric system is compulsory:

ASIA

Philippines (1860), Indo China (1911), Siam (1923), Japan (1924).

EUROPE

France (1794), Belgium (1820), Luxemburg (1820), Holland (1820), Spain (1860), Italy (1861), Germany (1872), Portugal (1872), Austria-Czechoslovakia-Hungary (1876), Switzerland (1877), Norway (1882), Yugoslavia (1883), Rumania (1884), Sweden (1889), Bulgaria (1892), Finland (1892), Iceland (1907), Denmark (1912), Malta (1914), Greece (1922), Poland (1924), U. S. S. R. (1927).

SOUTH AMERICA

Chile (1884), Columbia (1854), Porto Rico (1860), Brazil (1862), Equador (1865), Peru (1889), Argentine (1887), Bolivia (1898), Uruguay (1894), Guiana (1910), Venezuela (1914).

North America

Cuba (1858), Mexico (1906), Haiti (1921), Costarica, Panama, Guatemala, Hondurus, Nicaragua, Salvador (1912).

Africa

Algeria (1843), Tunis (1895), Portuguese East Africa (1910), Congo (1911).

Mineral Production of India

A picture of India's slow but sure recovery from the depression years of 1931-33, is provided in the annual account for 1935 of the mineral production of India prepared by the Geological Survey of India, which is published recently.

The total value of the minerals produced in India showed an increase from £17,666,511 in 1934 to **£19,518,273 in 1935**—manganese-ore increased a further 144.9 per cent., mica 33.9 per cent., lead 28.2 per cent., silver 36.7 per cent., zinc 41.9 per cent., nickel 21.8 per cent., iron-ore 19.4 per cent., chromite 54.8 per cent., ilmenite 49.8 per cent., monazite 230.4 per cent., zircon 576.4 per cent. Decreases occurred only with felspar 21.5 per cent., asbestos 69.5 per cent., and various precious stones.

This account, which deals with minerals produced in British India, the States and Burma, shows that the principal productions were:—

Coal	£4,903,822	(23,016,695 tons)
Petroleum	£4,685,338	(322,662,385 gals.)
Gold	£2,285,848	(327,652,5 ozs.)
Lead-ore	£1,010,414	(460,886 tons)
Manganese-ore	£950,630	(641,483 tons)
Building materials	£884,919	
Salt	£878,882	(1,948,178 tons)
Silver	£769,454	(5,850,406 ozs.)
Tin concentrates	£768,081	(5,859.7 tons)
Mica	£604,111	(58,754 cwts.)
Copper-ore and matte	£462,031	(350,801 tons ore & 8,950 tons matte)
Tungsten concentrates	£296,698	(3,837.1 tons)
Zinc concentrates	£285,666	(78,590 tons)
Iron-ore	£266,942	(2,364,297 tons)
Nickel-speiss	£105,269	(4,850 tons)
Saltpetre	£100,420	(12,623 tons)
Ilmenite	£58,789	(127,051 tons)
Chromite	£38,087	(39,127 tons)
Refractory materials	£30,301	(43,724 tons)

The year was notable for the steady prices for metals, with a general upward tendency except in the cases of tin, chromite and wolfram, which declined slightly.

Increasing interest in India's mineral resources is apparent from the larger number of new mineral concessions granted. During the year, 450 prospecting leases (including 287 in Burma), 86 mining leases and 31 quarry leases were taken out, as against 376, 57 and 49 for 1934. However, there is a long way to go before the peak year of 1927 (714 mineral concessions) is again reached.

Improvement in the mineral industry is further illustrated by the larger average number of persons employed daily, 371,522 in 1935 as against 334,848 in 1934. Most of the employment is provided, in order of importance, by the coal, salt, mica, gold, tin—tungsten-ore, petroleum, iron-ore and manganese-ore industries. These numbers are exclusive of those employed by the concomitant transport, smelting and refining industries, for example the metallurgical industries of Jamshedpur support a town of nearly 100,000 people.

A large proportion of India's mineral production is consumed in the country, the following shows the distribution of the principal minerals and metals:—

Coal	22,876,010	tons	consumed,
	217,584	tons	exported.
Petrol	92,280,483	gals.	consumed.
Kerosene	216,304,762	,,	,,
Fuel oil	137,438,345	,,	,,
Batching and lubricating oils	31,645,219	,,	,,
Salt	2,342,132	tons	consumed.
Pig Iron	980,845	,,	,,
	472,636	tons	exported.
Ferro-manganese	14,182	,,	consumed.
Copper	8,815	,,	,,
Tin	707	,,	,,
	1,883	,,	exported.
Magnesite	12,900	,,	consumed.
	4,084	,,	exported.
Clays	335,462	,,	consumed.
Steatite	12,596	,,	,,

It is interesting to note that India's consumption of brass was 38,769 tons during the year of which only 10,721 tons were produced in the country; there is room for considerable domestic expansion of the copper and brass industry.

To those who are optimistic of future great expansion in India's iron and steel industry, the figures for this trade should be taken as a warning. Production of iron-ore was 2,364,297 tons, exports *nil*. Production of pig iron 1,451.862 tons, retained imports 1,619 tons, exports 472,686, domestic consumption 980,845 tons. Production of steel 627.867 tons, retained imports 81,233. exports 559 tons, domestic consumption 708,541 tons. For manufactures of iron or steel other than those included under 'steel', the production figures are not available, but retained imports were 275,058 tons, exports 57,972 tons and consumption 217,086 tons (this latter figure is approximate).

From these figures it is quite obvious that India's production of iron and steel is almost up to her limit of absorption. Considerations of resources elsewhere indicate that India is not likely to have any great expansion of export trade in iron and steel. Japan is the largest importer of Indian pig iron with 576,025 tons—with Japanese agreements made elsewhere recently this figure is not likely to be sustained. The next largest importer, United Kingdom (117,092 tons), is buying increasing quantities nearer home.

Whatever expansion that is to take place, as a result of increased internal demand for iron and steel, is not likely to multiply the present figures for many years to come, and any individual company should remember that possible increase in domestic absorption will be spread over the production of several companies. In other words, anticipations of increases in production to 3 and 5 times the present figure should be treated with caution for many years to come.

The Indian manganese industry ten years ago occupied the premier position in world production. To-day India is a bad second and it is not unlikely that shortly the Gold Coast will exceed her production. The United Kingdom has been the greatest importer of Indian manganese ore, but increasing quantities are likely to be taken from the Gold Coast. Recent increases in Indian exports have been mainly to Japan, France and Belgium.

It is interesting to note that in the four years 1932-34, 799 tons of beryl were produced in Ajmer-Merwara, representing at present the largest production in the world. This rare mineral, used for special alloys, is likely to find an increasing demand as the matallurgical uses beryllium alloys have only recently become known.

Standardization of Weights and Measures

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In carrying out any measurement one has to employ units of measure as multiples or fractions of which the amount of the quantity measured is expressed. Of all the quantities measured the length is perhaps the most fundamental, and in every country the unit employed for the purpose has almost invariably been at one time or other some member of the human body like the foot or the arm. Unfortunately a human limb is not uniform in length; it varies from individual to individual and from race to race. As a consequence no two people or races have ever agreed in the length of their standard. Thus the Greek foot which was supposed to represent the length of the foot of Hercules was 12.14 English inches; the Macedonian foot 14.8 inches while the Sicilian 8.75 inches. In India *hasta*—the length of the forearm, *angula*—the diameter of the finger, *vitasti*—the span of the hand had been the measure of length in ancient times. These are still to be found in many localities specially among village people. In England the yard which afterwards became established as standard is supposed to have originally represented the length of the arm of King Henry I.

An evil consequence of relating the units of length to lengths of members of the human body has been that these units are different not only in different and the weights in gram fully knowing that the use of this system is strictly limited within the four walls of his laboratory and that he will never have to use it in daily transaction in his own country. Nor the parent or the guardian of the boy spends a moment's thought over the matter. He does not realise that in these days of keen competition and struggle all unnecessary waste of time and energy of a school-boy should be scrupulously avoided. If he did he would have demanded for a wholesale change.

Conclusion

It is natural to ask why, when so many countries have adopted the metric system Britain and United States are still standing aloof. The attitude of Great Britain has been particularly puzzling. As early as 1854 the Decimal Association of England started agitation for the adoption of the metric system. In 1864 a bill was introduced in the Parliament but failed owing to Government objection. A permissive bill was however substituted in its place. In 1871 another bill was rejected by only 5 votes. In 1878 the Weights and Measures Act was passed repealing the permissive act of 1864. In 1893 a representative group of British businessmen pressed this matter before the Chancellor of the Exchequer Sir W. B. Harcourt but he declined to intervene. Finally in 1897 a statute was passed making the use of the metric system legally optional and abolishing the penalty for having in one's possession a metric weight or measure.

It is indeed surprising why England should have such strong prejudice against this scientific and logical system of weights and measures. The question of national pride, the fact that it is of French and not of British origin can hardly be one of the reasons. All the principal nations have accepted it and I do not believe their national prides have suffered in any way. Nor the fact that during the period of transition from one system to another there will probably be a certain amount of confusion can be a sufficient cause for its non-acceptance. The real reason, I think is the innate conservatism of human mind. A conservatism which refuses to accept anything new and which conjures up all sorts of imaginary difficulties whenever any old established custom is sought to be changed.

To come back to the case of India it is obvious that acts like those of 1870-71 or 1920 by which the use of the metric system is only made legally optional are quite useless. What is needed is an act by which its use should be made compulsory. The benefit of such an act would be twofold. In the first place it will help to stamp out the existing heterogeneous system and introduce a uniform and logical system as is in use in most other countries of the world, and in the second place the decimal system of its secondary units will effect a great simplification in numerical calculations involving fractions of the primary units and a consequent saving of much time and labour.

The mere passing of an act would not of course be able to chase away the existing systems. Some propaganda work should be necessary. The first step should be to make its use compulsory in the railways managed by the government and in the bazars controlled by the city corporations. This should be supplemented by instructions in the primary schools where particular stress should be laid on the teaching of the metric system of weights and measures.

We do not see any reason, why with a little earnestness of purpose we shall not be able to achieve what other nations have already achieved. There is one thing to be said in favour of the reform of weights and measures. Unlike many other much needed reforms, the reform of weights and measures will not be an expensive proposition.

Notes and News

Medical Research Workers' Conference

The 14th session of the annual Conference of Medical Research Workers in India was opened by Major-General Sir Cuthbert Sprawson, Director-General of the Indian Medical Services at the School of Tropical Medicine, Calcutta. In his opening speech Sir Cuthbert reviewed the work done during the last year and remarked:

"The Indian Research Fund Association took up during the year two new lines of work, both of which are of great importance to the country. A special committee was formed to consider the ways and means of tackling the problem of maternal mortality in India. Though no accurate figures are available, an estimate made by Sir John Megaw, till lately Director-General of the Indian Medical Service, suggests that about 200,000 women are laying down their lives every year in making their contribution to the community. This figure equals the combined annual mortality in India from small-pox and plague and is nearly equal to the deaths from cholera every year. The problem is, therefore, one of the first rate importance from the point of vew of public health."

Another committee that was set up, continued the speaker, was the Nutrition Advisory Committee, which included agricultural and veterinary experts. "His Excellency the Viceroy, who has already expressed in many ways his interest in improving the nutrition of the masses in India, opened the deliberations of the Committee in July last. A special grant of Rs. 10 lakhs was made by the Government of India and of this Rs. 8 lakhs are being set apart for antimalarial work in the provinces and Rs. 1½ lakhs for nutrition research."

Sir Cuthbert remarked that past year had been an eventful one in the history of the Indian Research Fund Association and went on to say that "the financial position to the Indian Research Fund Association has, for the past few years, continued to be unsatisfactory and the researches financed by the Association have been eating into its capital recources. A Research Programme Committee was, therefore set up by the governing body of the Association with the purpose of scrutinizing all the current researches and of drawing up a programme of works in their order of urgency, the guiding principle being that the importance of any piece of research should be judged from a humanitarian point of view. The recommendations of the Committee have been referred by the governing body to the Scientific Advisory Board of the Research Fund Association and the Advisory Board will, in its turn, be largely guided in its decisions by the opinions expressed by the conference."

The Director-General, therefore, invited the conference to proceed with the deliberations and, at the same time, bear in mind that the governing body had laid down the principle that humanitarian considerations should determine priority in the matter of selection of the different pieces of research.

Sugar Industry and Unemployment

In the course of his recent broadcast talk on industrial development and unemployment, Mr. A. T. Weston, Director of Industries, Bengal, discussed the case of the Indian Sugar industry and its phenomenal growth under protection. The main difficulty in founding a new industry during years of depression is to find capitalists who will take the risk of investment. In the case of the sugar industry this risk was removed by protective tariff legislation which from September 30, 1931, imposed an import duty of Rs. 9-1 per cwt. which amounted to nearly 200 per cent on the price of Java sugar.

As a direct consequence the number of sugar factories in India increased from 32 to 156 in the five years 1931 to 1936. In other words the factory industry grew five times in five years and the production of sugar increased from about 158,000 tons a year to 760,000 tons a year in the same period. It can therefore be said that as the result of the effective shelter given to this one industry, over 100 new factories have been established in India with a paid up capitalization of over 10 crores of rupees and giving employment estimated at 500 chemists, about 500 mechanics, engineers, and supervisors, 1,000 clerks, storekeepers and purchasing agents under the control of about 100 sugar manufacturing experts, many of whom possessed European experienced training.

"This shows abundantly clearly what can be done to develop industry by giving it a sheltered market. In my judgment and experience no other measure taken by any Government has been so strikingly successful in this direction, as this action of the Government of India. The result shows clearly that where suitable conditions are already in existence, a policy of giving a sheltered market can stimulate industrial with all its opportunities for increased employment, and that few other measures or remedies can complete with this kind of action."

Gifts to Universities

It has been a lucky season for the British Universities. Soon after the announcement of the magnificient gift of a quarter million pounds by Sir Herbert Austin to the Cavendish Laboratory, Cambridge, came the news of Mr Frank Parkinson's gift of £50,000 to the University of Leeds for establishing a scholarship endowment fund. (SCIENCE & CULTURE, 2, 150, 1936). Last month we announced the gift of £1,250,000 to the Oxford University for medical research by Lord Nuffield. Now comes the news of Mr Parkinson's fresh gift of £200,000 to the Leeds University. This new gift will be used for building a central block to provide the main architectural feature of the whole of the university building scheme. Mr Frank Parkinson is the chairman of Messrs Crompton and Parkinson Ltd., and is an old student of the Leeds University.

Dr S. C. Law appointed Sheriff of Calcutta

We are glad to learn that Dr S. C. Law has been appointed the new Sheriff of Calcutta. Dr Law is one of the vice-presidents of the Indian Science News Association and is actively connected with many other public institutions, being a vice-president of the Committee for the Management of the Zoological Garden, Calcutta, a trustee of the Indian Museum, honorary correspondent, Zoological Survey of India, a Fellow of the National Institute of Sciences of India, a Governor of the Mayo Hospital and a Commissioner for the Port of Calcutta.

Dr Law is an enthusiastic ornithologist and has a fine collection of rare Himalayan birds in his aviary at Agarpara. He is a correspondent in Ornithology, Himalayan Club, and is the author of several books on Indian birds. He is also the editor of a scientific journal in Bengali, known as *Prakriti*.

Dr Law comes out of the well known Law family of Calcutta and is a prominent figure in the business circles of the city. He is the honorary treasurer of the Bengal National Chamber of Commerce and joint treasurer of the Federation of Indian Chambers of Commerce and Industry.

Roman Pottery Kiln at the Science Museum

A pottery kiln, in which small domestic articles were made at least sixteen hundred years ago at the time of the Roman occupation of Britain, is now on view to the public at the Science Museum, South Kensington. The kiln, which was crudely constructed of clay, is in an almost perfect state and is the only one to be seen in this country. It was discovered under the soil in the middle of a 80-acre ploughed field at Woodrows Farm, Compton, near the village of Aldworth, Berkshire. The preservation for more than sixteen centuries of such a fragile object is due largely to the fact that the ground beneath the surface soil in which the kiln was found is solid chalk; this fortunate circumstance made it possible to isolate the kiln from its surroundings. Under the supervision of Mr T. C. Crawhall, an officer of the Science Museum, it was encased in reinforced concrete and the total weight of 4¾ tons was brought safely to London by road without damage. In the Science Museum it is exhibited in a realistic representation of its original setting.

The discovery of this interesting relic, which makes such a useful contribution to our knowledge of an important craft of the past, is largely due to the recent introduction of the tractor-drawn plough and to the vigilance of the owner of the farm, Mr Kenneth Chapman, who noticed, when ploughing more deeply than was done formerly with the horse-drawn plough, that a portion of the ground had a darker appearance than the remainder and contained a number of pieces of broken pottery. He kindly reported his discovery to the Newbury Museum.

Research Notes

The Lower Ionosphere

The ionosphere or the radio roof of the world is responsible for the success of long distance wireless propagation, for if this did not exist radio signals would have left the surface of the earth and been lost in space. But the ionosphere consisting of ions and free electrons forces the signals down to the earth. Appleton and others found by experimental investigations that there are two chief layers—the E at a height of about 100 Km. and F at a height of about 250 Km. The latter is split generally during the night into two layers the F_1 at a height of 150 Km. and F_2 at a height of 250 Km. About a year and a half ago Prof. S. K. Mitra and his collaborators (of Calcutta) found existence of a lower layer of reflection at a height of about 50 Km. Subsequently they found also layers at heights of about 30 Km. and less. These discoveries were not at first given much credence, but confirmations of their existence have recently poured in from many independent quarters. Recently Colwell and Friend working at Morgantown, West Virginia University (U. S. A.), have obtained reflections from lower parts of the ionosphere (*Physical Review*, Oct., 1936, p. 632). One of the reflecting regions called the D region extends from 35-65 Km., the other the C region from 2-30 Km. This discovery has also been confirmed by Watson Watt, Bainbridge-Bell, Wilkins and Bowen working in England.

On a Rajgir stone image inscription

In an interesting article entitled "Rajgir (Maniar Math) stone image inscription" (*Journal of the Bihar and Orissa Research Society, 22,* 79-80, 1936) Mr K. P. Jayaswal discusses the portion of a concave frieze found at the Maniar Math site of Rajgir in course of archaeological excavation. This portion represents a figure seated on a hill. Below it there is an inscription in two lines. It runs thus: L. 1. *parvato Vipula*-L. 2. *Raja Sreṅika,* The literal translation of this inscription is as follows: The hill (is) *Vipula.* The king (is) *Sreṅika.* According to the author the exact significance of this inscription is that "the hill carved above is *Vipula,* one of the five hills of Rajgir; and the king carved on it is *Sreṅika*" (p. 80). The characters of this inscription are early Kushan (1st century A. D.). It has been held that *Sreṅika* mentioned in this inscription is no other than *Bimbisāra,* the Magadhan king. It is further opined that the fragmentary image probably represented the king *Bimbisāra.*

C. C. Das Gupta.

Use of Micro-organisms in Sugar Analysis

Harding and Nicholson (*Biochem. J.* 27, 1082, 1933) described a system of Carbohydrate analysis by the use of certain micro-organisms. The method made possible the quantitative analysis in dilute solutions of mixture of glucose, galactose, sucrose, maltose, lactose and fructose and mannose. But the differentiation of fructose from mannose was not possible by the use of the biological reagents employed at that time.

Micrococcus tetragenus (Gaffkya tetragena) produce acid from glucose, fructose and galactose but not from mannose, lactose or saccharose. Hence *Gaffkya tetragena* was used as an agent for the removal of glucose and fructose. Since *G. tetragena* removes glucose and fructose and *M. Krusei* removes glucose, fructose and mannose the reducing value of the mannose present in a solution may be obtained by subtracting the reducing value of the residual sugar left after the action of *M. Krusei* from that left after the action of *G. tetragena.* The authors have shown that (T. Nicholson, *Biochem. J* Vol 30. No 10, 1804, 1936) by the use of *G. tetragena* a ready separation of fructose and mannose when present in dilute solutions could be effected.

Combining its use with that of *P. Vulgaris* and *M. Krusei* it is possible to analyse mixtures of glucose, fructose and mannose and to recover added fructose and mannose from blood and urine filtrates.

H. N. B.

University and Academy News

Royal Asiatic Society of Bengal

An ordinary monthly meeting of the Royal Asiatic Society of Bengal was held on Monday, 7th December, 1936.

The following candidates were balloted for as Ordinary Members :—

Basu, Indubhusan, M.D. (Cal.), Medical Practitioner, Associate Professor of Medicine and Visiting Physician, Carmichael Medical College : 19, Vivekananda Road, Calcutta.

Dutt, Raghunath, Merchant, 167, Old China Bazar Street, Calcutta.

Mittra, Sarat Chandra, M.L.C., Landholder, 34, Shampukur Street, Calcutta.

Daga, Madangopal, Merchant and Landlord, 374, Upper Chitpore Road, Calcutta.

Banerjee, Satyendra Mohan, B.A. (Cal.), M.A. (Cantab.), I.C.S. Secretary, Board of Revenue, Bengal, 18/1, Ballygunge Circular Road, Calcutta.

Sen, Dhirendra Nath, Merchant and Landlord, 7, Rawdon Street, Calcutta.

Gillespie, Andrew Dollar, Chemist and Senior Partner, Messrs Bathgate & Co., 17, Old Court House Street, Calcutta.

Ghosal, Saradindu Mohan, M.B. (Cal.), M.R.C.P. (Lond. & Edin.), Lecturer in Medicine, Prince of Wales Medical College, Patna.

Bose, Ambuj Nath, M.B.E., M.D. (Lausanne) F.R.C.P. (Edin. & Lond.), Lt.-Col., I.M.S. Medical College, Patna.

Banerjee, Tridib Nath, M.B., M.R.C.P. (Lond. & Edin.), Professor of Medicine, Medical College, Patna.

Mookerjee, Benode Gopal, Zemindar and Merchant, 'Bakulia House', Kidderpore, Calcutta,

Austin, Arthur C., Civil Engineer, Deputy Chief Engineer, B.N. Railway, 16 Garden Reach Road, Calcutta.

The following papers were read :—

1. A. Benerji—*A Buddha Image from Kurkihār.*

Kurkihār is now a small village, about 23 miles east of Bodh-Gaya. It was visited by Major Kittoe in 1846 and 1848 who dug up a large number of statues from one of the mounds and deposited them with the Asiatic Society of Bengal, from where these have now found a place in the Indian Museum, Calcutta. The place was also visited by the late Sir Alexander Cunningham during the working season of 1861-62. After Cunningham's visit, Kurkihār remained neglected and its mounds became the favourite quarries of modern builders. The site has recently gained public notice by the accidental discovery of a large number of metal images of the Pāla period described by Mr K. P. Jayswal.

In this paper the author describes one of the sculptures, a Buddha image, found at the place. The image is made of black basalt and measure 4′ 9″ × 2′ 9″. He identifies the image as belonging to the Pāla period about the 11th or 12th century A.D.

2. A. H. Harley—*Abu Nukhailah. A post-classical Arab Poet.*

A biographical account of a well-known poet of the post-classical period of Arab literature, with translated specimens of his compositions, especially of those in *rajaz*-metre, in which he attained considerable celebrity. A note is added on the period of the efflorescence of this metre.

3. S. N. Chakravarti.—*A sculptured Lintel of Gupta Date from Sārnāth.*

A door lintel with reliefs on its lower face was discovered during the excavations at Sārnāth in 1907-08. The face on which the reliefs are found is divided into six panels. The intervening four panels illustrate a Jātaka scene. Pandit Daya Ram Sahni indentified the scene with the Pāli version of the Khāntivadi Jātaka. The writer of this paper, however, indentifies the scene with the Khāntivadi

Jātaka in the Jātakamala, a Sanskrit rendering of only thirty-four Jātakas, ascribed to Arya-Sūra.

4. G. E. Gates and M. Hla Kyaw—*The Clitellum and sexual Maturity in the Megascolecinae.*

Earthworms of the sub-family Megascolecinae either copulate in an aclitellate condition or else in a clitellate condition after which the clitellum disappears.

An attempt is described to discover if the second alternative is a correct explanation.

The following exhibits were shown and commented upon :—

1. Chintaharan Chakravarti – *Little known Works of two celebrated Tantric Writers.*

An account will be given, on the basis of the manuscripts of the Royal Asiatic Society of Bengal, of the *Tārāpradīpa* and the *Kālītattva*, two little known works respectively by Lakṣmaṇa Deśika and Rāghava Bhaṭṭa, who are well known as the author and the commentator of the famous Tantric work the *Sāradātilaka.* MSS. of the works are comparatively rare specially in comparison with those of the *Sāradātilaka* and its commentary. The MSS. that have already been reported are scarcely accessible belonging as they do to private collections many of which are no longer traceable. The society's MS. of the *Tārāpradīpa* brings up the total number of the known MSS. of the work to four all of which except the one in the State Library of Bikaner are in the Bengali script, showing that the work was little known outside Bengal. Though several MSS. of the *Kālītattva* were reported all that was known of the work was through a short notice by R. L. Mitra in the *Descriptive Catalogue of Sanskrit MSS, in the Library of His Highness the Maharaja of Bikaner.* The Society possesses two MSS. of the work, one of which in the Nagari script is fragmentary while the other in Newari script, acquired very recently, is complete but for one chapter and is in a fine state of preservation.

2. M. Mahfuz-ul-Haq—*A valuable Manuscript of an Urdu romantic Poem (Mathnawi) composed by Sharaf-un-Niṣā, a lady of Murshidabad (Bengal).*

This valuable, and apparently unique, manuscript, which formerly belonged to the library of the Nawwab Nazims of Bengal and now adorns my collection of Islamic manuscripts, is a long *Mathnawi* poem in Urdu, comprising 158 folios and containing more than 4,000 verses in the *Mutaqarib* metre. The poem was composed (about 1845) by one Sharaf-un-Nisā and dedicated to Nawwab Faridun Jah and his mother Ra'is-un Nisā Begum of Murshidabad.

It is probable that our manuscript is the original copy which was prepared from the author's draft as it contains additions and emendations in the handwriting of Sharaf-un-Nisa herself.

The poem is a fine and possibly the only extant specimen of the poetical composition of a Bengali Muslim lady of the last century.

Indian Physical Society

A meeting of the Indian Physical Society was held on Friday, the 18th December, 1936, in the Lecture Theatre of the Department of Applied Physics, University College of Science, 92 Upper Circular Road, Calcutta.

Following papers were read :

1. R. C. Majumdar : On the change of conductivity in longitudinal magnetic field.

2. J. N. Bhar : On the effect of meteoric shower on the Ionization of the upper atmosphere.

3. S. C. Sirkar : Raman effect at low temperatures.

4. P. C. Mukerji : On the Fluorescence spectra of rare earth ions crystals and solutions.

5. R. Ghosh : Angular distribution of showers produced in lead at high altitude.

6. M. K. Sen : The Band Spectrum of Gallium oxide and its Isotope effect.

7. M. K. Sen : Investigations in the Infra-red. Part II. The absorption spectrum of Boric acid.

Book Review

Fauna of British India-Protozea, Ciliophora—*By B. L. Bhatia, D.Sc., F.Z.S.,F .S.M.S., Published under the authority af the Secretary of State for India in Council, by Taylor and Francis, London.*

In this book on Ciliophora the author has incorporated his years of valuable experience on the subject and we believe that its publication has filled up a gap in the series published under the name of Fauna of British India, including India, Burma and Ceylon. It opens with a glossary of technical terms and then gives a systematic account of all the known ciliates described or recorded from India, Burma and Ceylon. It is profusely illustrated with typical figures in the text and have, in addition, eleven plates which depict the picture of ciliates found in the rumen of Indian cattle. In the introductory chapter the author has given a list of species found in different regions, and in case of parasitic forms in particular hosts, in the hope that these may be of use to workers in particular areas and to those working for the parasites in particular hosts. Thus a book like this is sure to render service to workers of all types including medical and veterinary. Principal methods employed in the study of Ciliophora have also been included here with the hope that those who intend taking up the study of this interesting group may find it helpful.

In all 310 species that are here included are but a small fraction of the total known from other parts of the world and the author rightly impresses this fact on the minds of future workers. Therefore, for future workers, this is more an up-to-date guide book than a complete work on Ciliophora as far as India, Burma and Ceylon are concerned. A complete list of bibliography given at the end of the book has, in a way, paved the way for future generration who may have fascination for this, though intricate yet extremely interesting, group of organism.

We strongl y feel that the publication of this volume has sown a seed of Protozoology on our rich Indian soil which, we hope, will soon bear fruits. We offer our hearty congratulations to the author who is the second Indian to have contributed to the series of Fauna of British India.

H. N. R.

Letters to the Editor

Emetine- d-Camphor -β- Sulphonate

It is well known that the injection of emetine hydrochloride is always very painful and further, the drug has a depressant action on the heart muscle and often produces feeble pulse and cardiac irregularities. So a search for an emetine compound having no such undesirable by-effects seems to be of considerable importance. This is more desirable if at the same time a compound of emetine be found, which might be administrated orally as it is now being generally recognised that emetine by mouth is more efficacious in the treatment of amoebic dysentery, than by injection.

Recently sodium salt of d-camphor-β-sulphonic acid is being largely used both orally as well as hypodermically as a general cardiac stimulant. It might be expected that a salt of this acid with emetine base would afford a product which might be safely administrated in all cases of amoebic dysentery[1]. Accordingly emetine (1 part) liberated from its hydrochloride was treated in chloroform solution with two parts of d-camphor-β sulphonic acid The chloroform solution was then concentrated on a water bath, cooled and diluted with petroleum ether when a solid separated out. This, on crystallizing from a mixture of absolute alcohol and dry ether, was obtained in clusters of needles, melting indifferently at 203-204° when heated very slowly. A nitrogen estimation of the compound agreed with the formula $C_{29}H_{40}O_4N_2$, 2 $C_{10}H_{16}O_4S$.

It is easily soluble in water and a 9.04% solution of the salt has a pH ca 4,9. The physiological properties of the compound are being studied and would be published elsewhere.

Research Laboratory, Bengal Immunity,
Baranagore, Calcutta. 3. 12. 36. U. Basu.

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[1] Carlos A. Grau., *Bull. Sci. pharmacol.* **42**, 452-6, 1935.

Hyderabad

Mohd. A. R. Khan

SITUATION, AREA, AND PHYSICAL FEATURES

At present the Nizam's dominions consist of the States of Hyderabad and Berar. Hyderabad State may roughly be described to include the portion of the Deccan lying between 15, 10′ and 20, 40′ north latitude and 74, 40′ and 81, 35′ east longitude, with an area of about 82700 square miles. It is for the most part a plateau with an average elevation of 1250 ft above sea-level. There are summits of hills, however, rising in places to 2500 and even 3500 ft.

The river Godaveri flows along a part of its northern boundary and the Tungabhadra a part of its southern boundary. Geologically the country is formed mostly of developed Deccan Trap with Archaean rocks in the north-west and south-east. In several places the soil is alluvial. Laterite is found in abundance in districts surrounding the city of Hyderabad. Gondwana rocks extend to a distance of 200 miles.

New-comers to Hyderabad are generally impressed by the curious configurations of its boulders, often resting in positions suggesting the intervention of giant hands. This is due mainly to the action of roots of certain indigenous plants assisted by the effects of atmospheric denudation.

Rich forests of teak and other valuable timber trees abound in the north-eastern and other parts of the country. There are several more or less natural lakes dispersed amongst the hills the largest of which is the Pakhal in Narsampet Taluga, extending over an area of about 13 square miles.

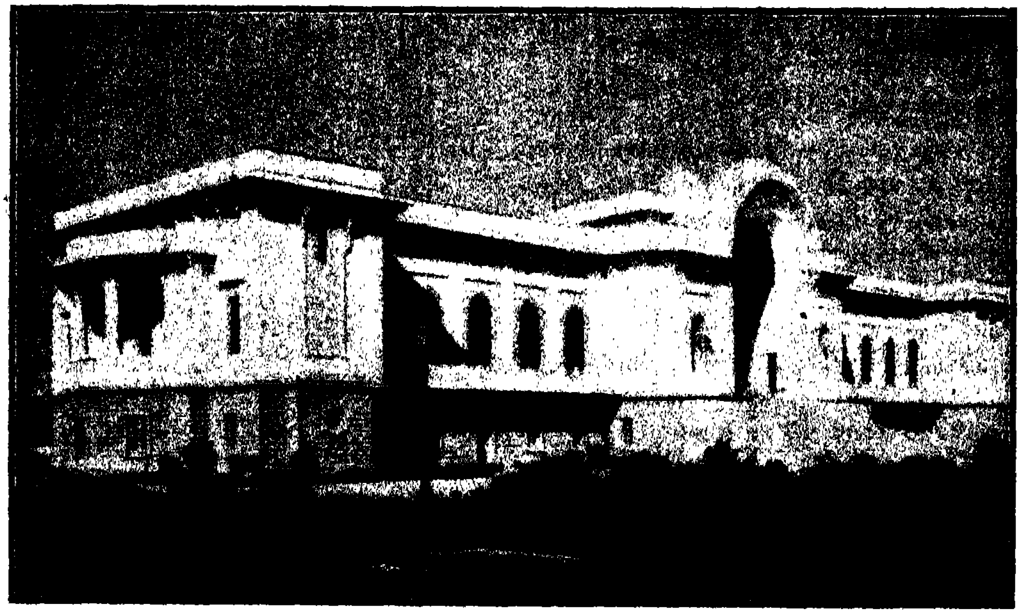
The bulk of the rainfall is derived from the south-west monsoon, which prevails from June to September. The north-east monsoon which sets in later (chiefly in October and November) also contributes much to Hyderabad rainfall, especially when the earlier monsoon fails to come up to the usual mark. The sky is generally clear in winter though it may occasionally be shrouded in thick mists in the mornings. Copious rainfalls often dissipate the heat of summer, accompanied usually by thunder and at times by hail-storms. The average rainfall may be taken as 28 inches, though in some epochs it rises to as high as 35 inches. The average temperature is estimated at 81° F. Often in winter the thermometer goes down below 55° F and in summer rises to 105° F or more.

H. E. H. Sir Mir Osman Ali Khan Bahadur G.C.S.I., G.C.B.E., the Nizam of Hyderabad and Berar

BRIEF HISTORY

The history of Hyderabad may be traced to pre-Aryan times. Dravidian culture of all ages has left its mark on the topography of many a town and village in the country. Its many hill-forts, like of Devgiri (modern Daulatabad), Bhongir and Golconda, and its temples at Warangal, Bhadrachalam etc. bear testimony to the great influence wielded by the powerful Hindu Kingdoms of by-gone ages over the length and breadth of the country.

In more recent times the Bahmani and Vijaynagar Kingdoms rendered this part of India famous for its great achievements in arts, learning and industries. As an outcome of constant interaction, both friendly and antagonistic, between the two great Muslim and Hindu civilizations, a peculiar trait has developed in the character and general outlook of the peoples of this part of the Deccan, which differs considerably from that of the peoples of northern and southern India.



THE STATE LIBRARY

The Bahmani Kingdom originated at the middle of the fourteenth century A.D., as a result of the slackening of the hold of the Afghan Kings of Delhi on their territories south of the Narbada. Gulbarga was first the seat of their government. With the weakening of the central authority it broke up into smaller and more or less independent principalities, *viz.* those of Bedar, Berar, Ahmadnagar, Bijapur and Golconda. After the downfall of Vijaynagar, there being no incentive to mutual support and co-operation these petty off-shoots of the Bahmani Kingdom deteriorated one after another, each attaining for a time to a position of pre-eminence among themselves, and leaving imperishable records of their well-developed culture in manuscripts, coins and sepulchral architecture.

When the Moghal Empire rose to its zenith during the reign of Aurangzeb, one by one, these quasi-independent 'Kingdoms' were subjugated and brought under the direct control of Delhi. But the court intrigues and internecine wars that followed the death of Aurangzeb soon reduced the power of Imperial Delhi to a mere shadow. and it was then that the famous Nizam-ul-Mulk, Asaf Jah the first, took over the Subahdari of the Deccan and saved this heritage of the Great Moghal from ruination.

By 1724 he became independent of Delhi and established his rule not only over the six Subhas of the Deccan but also the tract of country extending from the Tapti to the frontiers of Mysore and the Carnatic, right down to Trichinopoly. After his death in 1748 there was a rush among his sons and grandson to seize the supreme power, which involved the intervention of the French and English forces tha had obtained by this time a firm foot-hold on Indian soil.

The struggles ended in the accession of Nizam Ali Khan to the throne of Hyderabad (1761)—the first ruler to assume the title of Nizam. He entered into several treaties with the East India Company through the Governor-General of India, of which the most important one is that of 1802. It was during his rule that the Paigah Amirs were invested with jagirs and the special privilege of protecting the person of the Nizam and the State with efficient armies.

Sikandar Jah succeeded Nizam Ali Khan in 1803, and ruled till 1829. It was in his time that the question of maintenance of the contingent and the assignment of Berar—which later assumed an important forensic aspect—first cropped up. Then followed in succession Nasir-ud-Daulah (1829-1857), Afzal-ud-Daulah (1857-1869) and Mir Mahbub Ali Khan (1884-1911).

During all this period the Nizams remained staunch friends and allies of the British. The Sepoy Mutiny of 1857 did not extend to the Nizam's Dominions. His armies gave a helping hand to the British Government to quell the mutiny. In recognition of the support received from the Nizam in men, money and sympathy, the British Crown has designated him as a faithful ally.

ADMINISTRATION

During the reign of Nizam Ali Khan the whole State was divided into Khalsa, Paigah, Jagir and Sarf-e-Khas. But there was no separate department of Revenue. Land was given away on contract to men called Taluqdars and the State expenses were met by proceeds obtained therefrom. The village with its hereditary offiicers called Patels and Patwaris played an important part in the revenue collection.

The Nizam enjoyed absolute sovereignity of the State and the government of the country was based more or less on the lines of the Imperial Court of Delhi. During the latter part of Nasir-ud-Daula's reign the Taluqdars with fixed salaries (and a regular staff of subordinate officers) were appointed by the government, and the system of revenue farming was abolished.

The late Nizam, Nawab Mir Mahbub Ali Khan, introduced wholesale reforms in the entire administration, bringing it more or less into coincidence with the system prevailing in British India. The Cabinet Council, the Legislative Council, and the method of government through a Prime-minister and Assistant ministers, in charge of various departments, were established. Inspite of the complications caused by the famine of 1898, the finances of the State rapidly improved through judicious economy and watchful supervision. The cash deposits and securities which amounted to one crore and 30 lakhs in 1901 rose to 5 crores in 1910.

The Golden Age of Hyderabad synchronized with the accession (in 1911) of the present ruler, His Exalted Highness the Nizam of Hyderabad and Berar, Nawab Mir Osman Ali Khan Bahadur G.C.S.I., G.C.B.E. In the Great War of 1914-1918 the State heroically came forward with its abundant resources and took a most prominent part in the help given by Princely India to bring the war to a successful issue. On 17th November, 1919 H.E.H. sanctioned the New Constitution which entrusts the government of the country to the Executive Council, at present consisting of the Sadr-e-Azam as President and six members each in charge of the main departments of Finance, Law, Military, Revenue, Politics, and Public Works.

The Legislative Council had already acquired wide powers of legislation under the Legislative Council Act of 1900. It was reformed later and consists now of President, a Vice-president and 19 members, two of whom are extra-ordinary. The President of the Executive Council is also the President of the Legislative Council, and the minister in charge of the department is the Vice-president. Of the members, 11 are official, 3 of whom *viz.* the Chief Justice, the Judicial Secretary and the Legal Adviser to H.E.H. the Nizam's Government (who is also the Secretary of the Council) being Ex-officio. The remaining six members are non-official of whom two are returned by Jagirdars of certain standing, two from the High Court Bar elected from among the members of the Bar Association and two nominated by the President – one from each of the Paigahs in turn and the other from the general public. The term of membership is two years, members being eligible for re-election or re-nomination. The High Court with a number of Lower Courts of Justice under it—located both in the city and the districts—has been granted a Charter defining its powers and position in the scheme of State Government. It got further powers when the High Court Act was passed by the State Legislature. A number of reforms have been introduced into the State Judiciary based on the Report of the Civil Justice Committee appointed by Lord Reading. By far the most important reform which gives Hyderabad a lead in Indian Administration is the *separation of Judicial from Executive functions.*

Appointments to gazetted posts in civil departments are made from candidates that have passed successfully from the Hyderabad Civil Service Class, admission to which takes place on the result of an open competitive examination.

The New Municipal Act passed in 1934 has made the City Municipal Board a more democratic institution, representative of the interests of various sections amongst the citizens of Hyderabad. As at present constituted, it is presided over by a commissioner under the Political Member and consists of 36 members including the Vice-president elected annually by members from among themselves. 13 members (of whom one is a Parsi, one a Christian and one a representative of Harijans) are nominated by the Government. One member is returned by the Sarf-e-Khas, three by the Paigahs, one by the Salar Jung Estate, one by the Maharaja Krishen Pershad Estate, two by the Jagirdars, one by the graduates and one by the mercantile class. The remaining 13 are elected from the thirteen wards into which the city has been divided. The term of office of the elected and nominated members is 3 years.

Controlled by the Revenue Secretariat there is a District Board at the head-quarters of each district, and a Taluq Board at the head-quarters of each taluq, that are in charge of the Local Funds collected in the districts and villages respectively. Membership to these boards is provided partly by election and partly by nomination.

AGRICULTURE AND IRRIGATION

Agriculture forms the principal means of subsistence in the country. Government experimental farms have been established under the Agricultural Department at Himayat Sagar, Parbhani and elsewhere to demonstrate scientific methods of crop culture, animal husbandry and poultry breeding etc. Rural uplift work is financed by the Government Industrial Trust Fund.

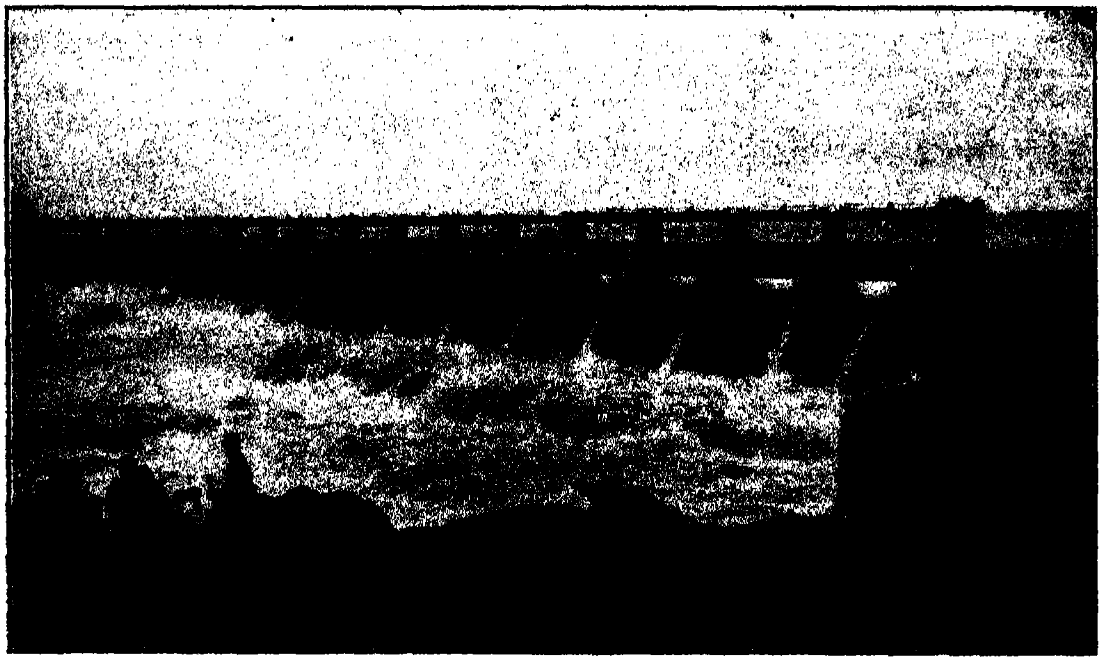
In the field of irrigation the State has achieved a marked success. Dams accross the rivers Musi and Isi have not only safeguarded the city of Hyderabad from the danger of future floods, they have furnished almost unfailing sources of water supply to the capital and its outlying districts, in the reservoirs of Osman Sagar and Himayat Sagar. Leaving aside the minor projects whose number is large, mention may be made of the great reservoir in Nizamabad, called Nizam Sagar, which has a dam across the Moujera river 7260 feet long, 111 feet high and a capacity of about 26000 million cubic feet. Its waters will irrigate vast tracts of land under sugar-cane and other crop-cultivation.

Co-operative movement is spreading far and wide into the country. There is one Dominion Co-operative Bank and one Central Co-operative Union Bank with a number of other Central Banks which have done a lot to save the agriculturists (and others) from the clutches of usurious money-lenders.

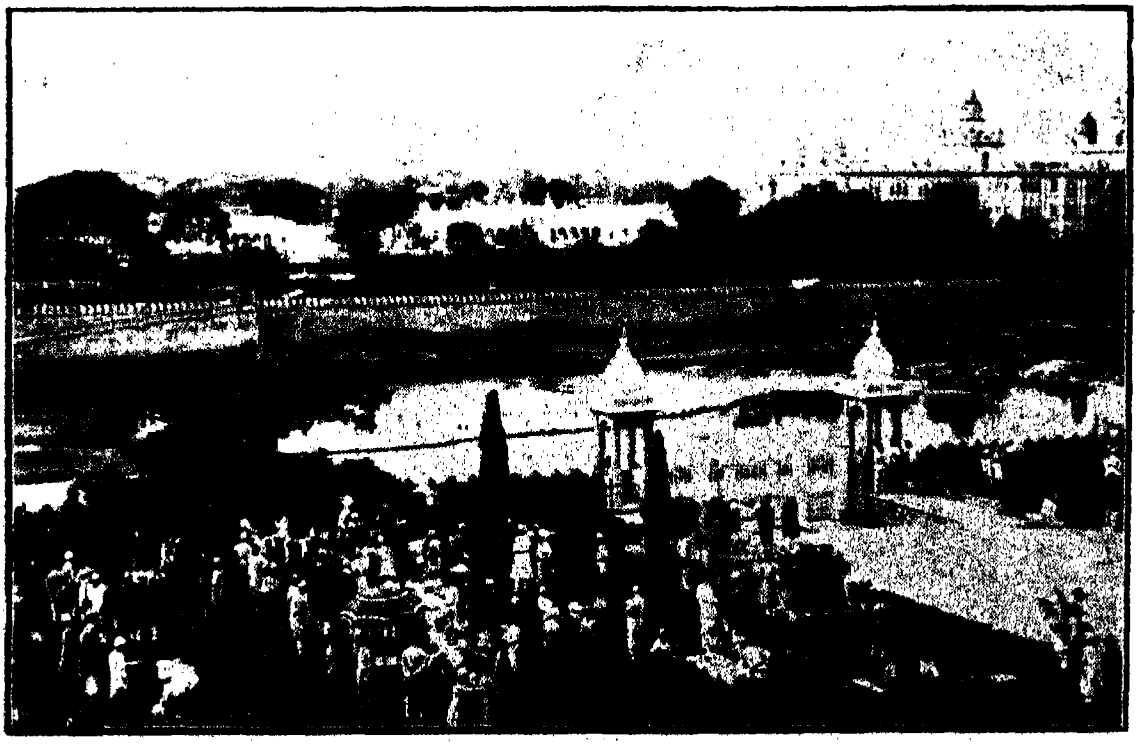
The condition of the land-cultivators is on the whole very satisfactory; their farms are reported to be less encumbered with debts than those in other parts of India.

FINANCES AND DEVELOPMENT

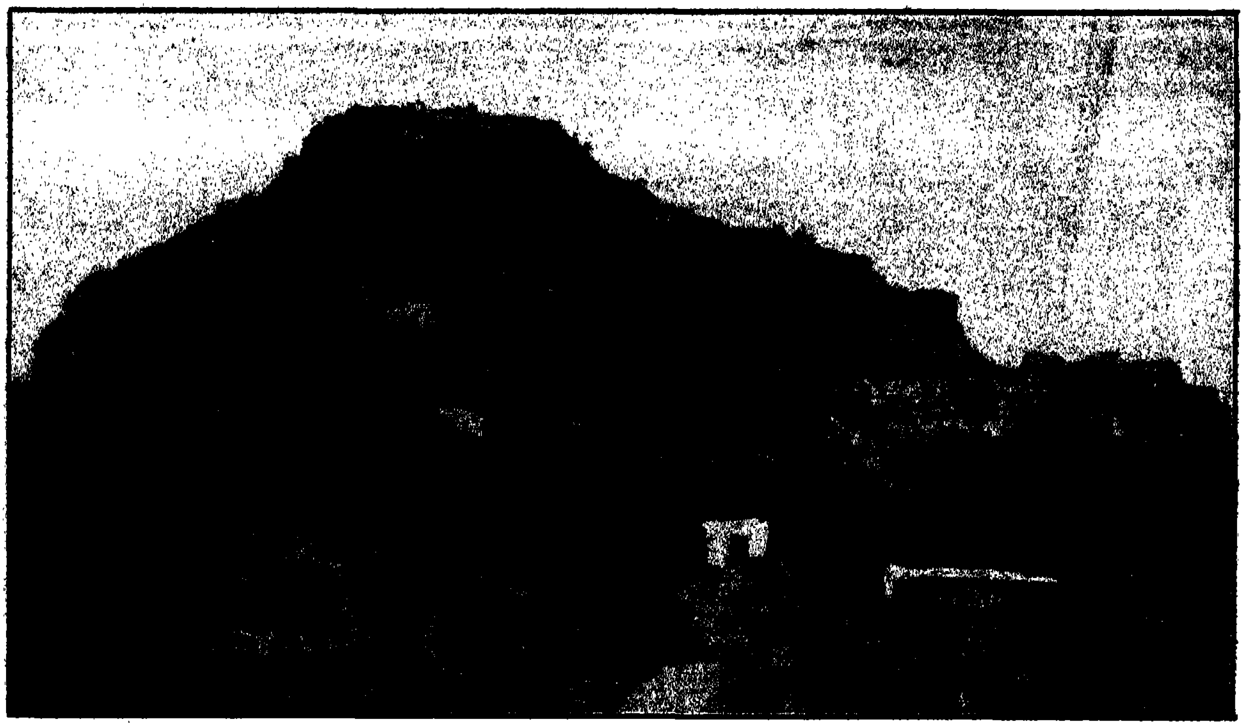
During the reign of the present Nizam, in spite of general economic depression all over



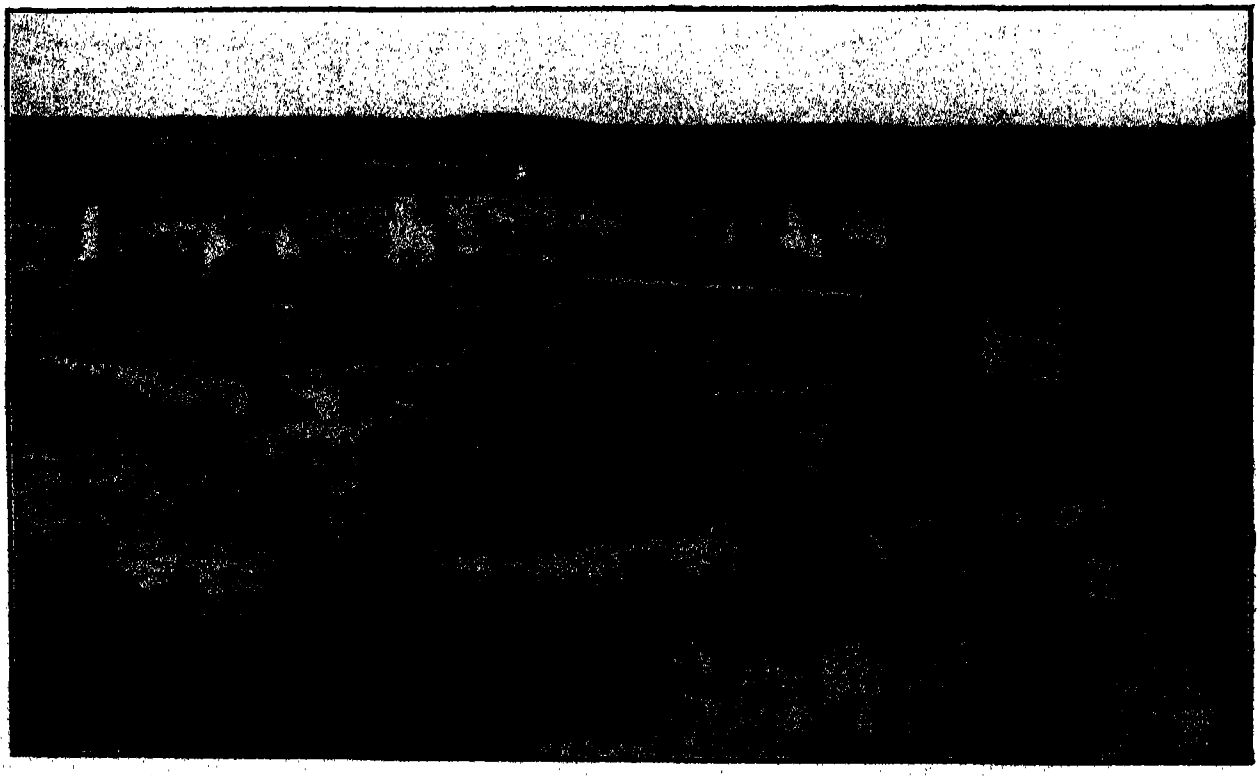
IRRIGATION WORKS AT NIZAMSAGAR



A VIEW OF THE MUSI RIVER WITH THE OSMANIA GENERAL HOSPITAL IN THE BACKGROUND



DAULATABAD—THE FAMOUS HILL FORT



GOLCONDA

India, the finances of Hyderabad have maintained a perfect stability. Without increase in taxation, without retrenchment and inspite of heavy remissions of land revenue and the carrying on of great projects of economic development, (like purchase of railways and railway buses etc.) the State has been able to show an annual surplus over expenditure in its budget reports. During the last decade the revenue has steadily increased from about 7½ crores to 8½ crores per annum.

Industries are gradually making headway under the scheme of government loans from the Industrial Trust Fund. The Cottage Industries Institute at Mushirabad is showing good progress. The cigarette factory in the same locality, which is owned by a private company is in a very flourishing condition. Mention may be made of the Koh-e-noor glass factory at Amirpet, the button factory in the city, the soap factory, the distillery, the Taj brick works etc. all private concerns and in fairly good condition.

The Cement Company at Shahabad is a highly profitable business. Good cloth is manufactured at the Osman Shahi and Ajam Jahi mills.

The State possesses four coal mines, those of Singareni, Tandur, Kanala and Sasti, and Paoni. In 1932 the total output of coal from these collieries amounted to 7,47,387 tons. The old diamond mines and gold mines are no longer workable. But the quarrying of Shahabad stones and marble is found very profitable and fetches a good royalty.

CENSUS AND ETHNOLOGY (1931)

At the last census (1931) the population of the State was found to be 14,436,148. Hindus (comprising mainly the Telegus, Mahrattas and Canarese) form the majority. Next in numerical order come Mussalmans. Indian Christians constitute a large number. There is a sprinkling of Parsis in the bigger towns. Jains flock in great numbers at the business centres. The Sikh Gurdhwara at Nander attracts a number of pilgrims every year and several are in permanent residence there and elsewhere.

With the rapid spread of education illiteracy among the poor classes is fast diminishing. Though the chief vernaculars are Telegu. Mahratti and Canarese in the Andhra Mahratta and Canara districts, urdu—the State language is understood and spoken by practically every inhabitant of Hyderabad unless he belongs to some of the aboriginal tribes that lead a semi-wild life in the jungles. Some of the keenest scholars of Urdu and Persian are to be found among the members of the Hindu community of Hyderabad.

EDUCATION

In no department has the country shown such marked progress during the past 25 years as in education, though every department has contributed its full share to the general prosperity of Hyderabad. Since 1911 the sum spent on education has risen from 14 lakhs to over 1 crore 3 lakhs. The following table gives an idea of the present state of education in its various aspects :-

PRIMARY EDUCATION

3694 Primary Schools for boys and 674 for girls.

SECONDARY EDUCATION

Practically all the big and small towns in the Dominions are provided with secondary schools. Their present number is 184, with 68, 843 scholars.

(In the city of Hyderabad there are several High Schools the most important of which are the City Collegiate H. S and the Chaderghat High School for boys and Nampalli Collegiate H. S. and the Mahbubia School for girls. The strengths of these schools are 1254, 1134, 555 and 345 respectively). There are 50 boarding houses in the Dominions and the scheme for a few more is under consideration.

UNIVERSITY EDUCATION

The Osmania University (which will be discussed under a separate heading) and the Nizam College. The latter institution is affiliated to the University of Madras and has a fine laboratory and a Library.

(The Madrasa-e-alya High School is of even an older standing than the Nizam College) with which it is connected. Some of the highest officers of the State have been old boys of this High School).

FEMALE EDUCATION

The expenditure on this head amounts to Rs 9, 89, 227 per annum. For the convenience of pardah girls especially, the State has arranged for conveyances in all the Girls' Schools.

TRAINING INSTITUTIONS

9 for the training of Primary matriculates and Intermediate teachers. In these schools Urdu, Telegu, Marathi and Canarese are the media of instruction. 5 are for training of men teachers and 4 for women.

INDUSTRIAL TRAINING

In towns where indigenous industries like himree weaving, bidri work, silk industry etc. flourish the State has opened industrial schools for the training of aspiring artisans.

ADULT EDUCATION

To fight illiteracy 45 schools have been established in the city of Hyderabad and the districts. At present 1531 adults are reading in them.

DEPRESSED CLASS EDUCATION

Over 100 schools with nearly 4000 students.

PHYSICAL EDUCATION

This has been made compulsory in every school. For the training of teachers in this branch of education a college has been started in the capital.

TECHNOLOGICAL EDUCATION

Central Technical Institute equipped with workshop appliances etc.

A college has been established for the especial education of the sons of Jagirdars. It is located at Begumpet and has 192 students in residence at its premises, which command an imposing view and are noted for their fine game fields.

The State has been giving scholarships and loans munificiently to boys and girls for higher education in foreign countries, especially England. As a result of this, there are perhaps more men with European degrees and diplomas to be met within Hyderabad than in any other city in Asia of its size.

THE OSMANIA UNIVERSITY

As is well known, the medium of instruction at this University is Urdu, the common language of the country. It was established by a Charter in 1918. Till 1934 all its main colleges and institutions worked in rented buildings in a suburb of the city. There the University College built up its classes in the Faculties of Arts, Science, Theology and Law from Intermediate to Post-graduate and Research standards. When the University was transferred to its new buildings at Adikmet (covering an area of 1400 acres of land) it had already over 700 students in the University College alone. With much greater facilities for expansion, its vast stretch of buildings, well-equipped laboratories, fine library, commodious hotels and extensive play-grounds, it bids fair to become one of the most important centres of learning in the East. There has already been a marked increase in the number of its students and its activities.

It comprises at present the following units :- University College, Medical College, Engineering College, Training College, Women's College and the Intermediate Colleges in the city., Aurangabad, Warangal, and Gulbargh ; besides the Translation Bureau, the University Press, the Nizamiah Observatory and the Registrar's Office. All the above institutions, except the Medical, the Training, the Women's and the Intermediate Colleges and the Nizamiah Observatory are located at Adikmet.

The Observatory is situated at Begumpet. Its principal equipment consists of 2 Equatorial telescopes, one 8 inch photographic and the other is a 15 inch visual refractor, besides 2 Milne-Shaw Seismographs and apparatus for meteorological observations. The Translation Bureau is entrusted with the supervision of translation and compilation of Text books etc. for the use of the University.

The Dairat-ul-Maarif where rare Arabic manuscripts are edited and published is an endowed government institution under the control of the University.

ARCHAEOLOGY

The country is rich in relics of by-gone ages. The world famous caves of Ellora and Ajanta need no introduction. Liberal grants have been made by the State for the restoration and maintenance of these famous monuments. The sum allotted to the department in 1932 amounted to well over 2 lakhs. The Guide to Ajanta Frescoe and Hyderabad State—a Souvenir fully describe these caves and may be purchased from the museum recently opened in the Public Gardens. Here, among other interesting objects one may see many flint tools of the Stone Age ; pottery and fragments of iron implements discovered in Pre-historic graves.

PRINCIPAL CITIES

Next in importance to the capital city, come Aurangabad rendered famous by its association with Aurangzeb and the early rulers of Asaf Jah dynasty, Warangal, with its far-famed temple of 1000 columns, Gulbargah, the headquarters of the Bahmani kingdom, Bidar, with its tombs of Barid Shahi Kings and modern artistic metal work. Among smaller towns of importance may be mentioned Bhongir, Nizamabad, Latur, Jalna, Mahbubnagar etc.

TOPOGRAPHY OF THE CITY OF HYDERBAD

This city was known as Bhagyanagar in the days of the Qutub Shahi Kings. With the accession of the Asaf Jah dynasty it rose rapidly into importance and soon outgrew the confines of its heavy stone-built walls. The Char Minar and Mecca Mosque at the centre of the city are imposing monuments. The King Kothi, the residence of H. E. H. the present Nizam and the Falak Numa Palace where distinguished guests of Viceregal and royal rank, are entertained in residence, are noble buildings. H. H. the Prince Azam Jah of Berar (the Heir-Apparent) resides at the Bella-Vista Palace at Somajigura and Wala Shan Prince Moazzam Jah at his palace Naubat Pahar overlooking the Fateh Maidan.

The palaces of the nobles and the rajahs of Hyderabad combine modern comforts with old-world glory. Permission may be obtained to viist some of them.

The re-building of Hyderabad after the floods of 1908 (which commenced with the appointment of the city Improvement Board) has now furnished the left bank of the river with beautiful gardens. The Osmania Hospital, the State Library, the High Court and the City Intermediate college are impressive buildings located on either side of the river.

The Town Hall, the Public Gardens, the Mint (where the State's own coins of gold, silver, nickel and copper are uttered and its own postal stamps are printed); the finance and other Government offlce buildings and Saifabad add to the picturesqueness of the city, which with its miles of cement roads, electric lighting, drainage schemes, and anti-plague, anti-malaria campaigns, is not only one of the finest in India, but also one of the healthiest to live in.

A special feature of Hyderabad is its fine aerodrome and landing grounds for aeroplanes at Begumpet where the foundation stone of the air port building was laid recently by Her Highness, the Princess Dur-e-Shahwar of Berar.

One should pay a visit to the historic fort of Golconda, the tombs of the Qutub Shahi Kings and the lakes of Mir Alam and Husain Sagar which are very close to the city.

CONCLUDING REMARKS

Hyderabad State has played a very important part in welding the Aryan and Muslim north of with Dravidian south. Hyderabad culture is as a happy combination of Moghal and Indo-English traits. The liberal policy of the house of Asaf Jah and the religious and economic tolerence which peoples of every caste, colour or creed enjoy in the state, have built up a nationality that bids fair to extend all over India and thus bring about a real unification of its teeming millions.

The Indian Village—Its Past, Present and Future

Presidential Address, January, 1937

Rao Bahadur T. S. Venkatraman, B.A., I.A.S., F.N.I.
General President, Indian Science Congress, 1937.

INTRODUCTION

I take it no apology is needed in these days for talking about any aspect of 'village and village life'. The city and the town which were holding a complete thraldom over the public mind all these years are losing their glamour somewhat in spite of their admittedly alluring attractions; and the 'village' would appear to be getting increasing recognition, particularly in our country and in recent times.

I propose to speak to you to-night under the caption 'The Indian Village—Its past, present and future'. You might perhaps question my claim to speak on this subject as all my official life and thought for the last quarter of a century has been linked up almost entirely with sugarcane. But this very work has often taken me to the countryside in various parts of India and my contact with the Indian village has been fairly intimate. While at my special work I had perforce to witness the pleasures and tragedies of the villager and watch the changes that are steadily coming over the village. Secondly, most of us—in this agricultural land of ours—have come from villages and are in fair contact with village life either directly or through our kith and kin.

One easily noticed change, in the village, is the migration of the villagers to the town. The richer of the villagers show a tendency to shift themselves to the nearest town or city for the education of their children, for better medical help or for the characteristic amenities associated with urban life. Secondly, the more intellectual of the younger generation, who first migrate to the towns for their studies or to seek employment, do not generally return to the village, but settle in some town which they find more congenial for the full scope of their talents. If they do pay a visit to the village it is either to see an old relative who is too conservative to move to the town or in connection with some matter which renders their presence in the village unavoidable. Such visits are made of as short duration as possible and they get back to the town with almost a sense of relief.

POSITION OF INDIA WITH REFERENCE TO SPACE AND TIME

But before getting into the subject proper it is necessary to record here a few general observations on the position of our country with regard to both space and time view-points. With China, Japan and the South Eastern islands, India is situated in a comparatively densely populated area of the globe—about half the population of the world being crowded into a tenth of the Earth's land region. This has had its effects on the type of agriculture practised in the country, the selection of crop for cultivation, and the life of the people as a whole.

Secondly, along again with China, India possesses a civilization and culture which was at least contemporaneous with, if not antecedent to, the civilizations of Egypt, Mesopotamia, Greece, and Rome. After making considerable progress this civilization has, however, remained in a more or less quiescent and petrified state in our villages for well nigh two to three thousand years little influenced by the great progress made by the West during the latter part of the same period. It is only within comparatively recent times that the Western civilization has come to spread into and influence countryside. In more senses than one the Indian town represents the dynamic West with all the vigour of youth and the village the comparatively quiescent East. Certain of the problems of the village to be discussed hereafter will be found traceable to the inevitable contact between the two.

ARYAN COLONIZATION OF INDIA AND TYPES OF VILLAGES

In early times there were two chief passages into India—one on the north-east through Assam and Bengal and the second on the north-west into the Indus region. The Aryans, who entered the country through the north-west route, first occupied the Indus valley and the Punjab plains and later spread to the east of the Jumna as far as the Saraswathi. Subsequently they spread into Bengal and from there would appear to have sent out expeditions by sea to Burma, Ceylon and Java. The Vindhya ranges and the Aravalli hills long acted as an effective barrier against large movements southwards into the Deccan and South India. The country to the south of these ranges remained for long Dravidian, though increasingly influenced by Aryan culture from the north.

The Ryotwari village - The new Aryan colonists naturally found plenty of land to settle in and the obvious advantages of group formation brought into being two main types of villages. One was the type similar to what is now termed 'ryotwari' where each family or group of persons took up as much land as they could cultivate depending on the number of cattle and able-bodied men in the unit. Site for the village was chosen at some convenient spot such as the bank of a river or canal or proximity to other sources of water supply. The persons constituting the village chose a Headman who exercised all powers on behalf of the whole community. This type of village was generally associated with peaceful conditions.

Joint village—The other type called 'Joint Village' by Baden Powell was founded by powerful families or clans not necessarily agriculturists. The government of such villages was by the well-known Panchayat system and occasionally a group of such villages belonged to the same clan or owed some kind of allegiance to the same warrior chieftain in return for the protection they enjoyed at his hands. In these villages the cultivating classes were sometimes in the position of tenants. 'Ryotwari' villages sometimes got converted into 'Joint Villages' through conquest by some warrior chieftain.

THE INDIAN VILLAGE IN THE PAST

Various books, such as the Arthasasthra of Chanakya (before 300 B.C.), the Sukranithi and the Smrithies of Manu as well as inscriptions unearthed in recent times, give us a fairly clear picture of the organization and government of the village and its institutions in ancient times. The Agamas and the architectural books of South India contain references to the plan and lay-out of the village; the temple which formed an essential unit in the lay-out influencing and being influenced by the village plan. The villages of South India would appear to have attained a high degree of perfection absolutely unaffected by Aryan influence from the north, so much so that certain authorities hold that some of the Aryan village institutions were copies of the Dravidian. The basic plans as revealed in these villages existing to this day deserve the careful attention of persons engaged in town planning and rural reconstruction. The Manasara (25 A.D.) describes in great detail the lay-out plans of villages, towns and forts as well as the ground plan and elevation of houses, palaces, and buildings for common use like public halls and the theatre.

The Headman—The Headman was an important officer in village government. His office was hereditary and apparently a vestige of the ancient village chief. He was remunerated by grant of inalienable right to certain lands and later by being allowed to collect and utilize certain taxes from the villagers. He was entitled to collect annually, for instance, two shoes from every shoe-maker, two cloths from the weaver, 13 betel leaves (per day) from the betel leaf vender and a cash moiety from the shop-keeper. He was Gramani or King of the village.

The Village Panchayat—The Headman was assisted and later on effectively controlled by the village Panchayat. This was a *Council of Elders, not elected,* and more or less self-constituted from the elders of the village who naturally and easily commanded the respect of the villagers. Justice was dispensed in the village temple and an oath before the local deity was potent in preventing persons from bearing false witness. The Panchayatdars also knew the parties almost personally and were thus able to dispense quicker justice. The Panchayat administered the village funds and thus commanded facilities for catering to village needs. Even after the British came into possession, 22 per cent of the collection was given back to the villages over portions of the Maharashtra country.

An Autonomous Unit—The village was practically autonomous and once the tax from the village as a whole was paid it had little to do with the Central Government and was not affected by change of dynasties. Later on, however, when during the troublous times following the downfall of the Moghul Empire wars were carried into the villages as well, they naturally had a share of these troubles. In later times larger political units came into existence having overlordship over groups of villages, though even then each individual village exercised a great deal of self-government in matters pertaining to the village. It is interesting to learn that during Chandragupta's times (320 B. C.) there was a permanent organization for taking census.

Taxes for common needs—The village government was carried on in a brotherly informal way, the opinion of the elders carrying much farther than now. Taxes were levied for communal purposes as distinct from those by the Emperor; and there was a common village fund which entertained the village guests, provided for the indigent and arranged for recreations, shows and performance of acrobatic and jugglery feats. The temple, the village tank, the guest house, as well as other public utility concerns had a claim on this common fund. The central government helped in cases where works of common utility were beyond the capacities of the village. This help was given either by the waiving of certain imperial taxes or by contributions in kind. The tax was sometimes levied in the form of manual labour and this is responsible for the huge and elaborate temples found in the south of India, some of them containing priceless treasures of sculptural and other arts. Occasionally also loans were raised by mortgaging the revenues of the village for definite periods.

Village life- There was not much sanitation in the modern sense of the word and no scavenging. The Arthasasthra lays down a space five cubits wide behind each house apparently as a sanitary lane. Regular sweeping of the village streets was not common and the watchman who was responsible for sanitation thought his duty done when he pulled any carcasses out of the streets. Diseases were naturally few on account of the healthier open life and there was no organized medical relief, though there is a record of such measures during Asoka's time. The kitchen store contained most requisites for common ailments and the elder generally knew a few simple remedies from experience. The science of healing was, however, well advanced for the then conditions and comparatively cheap being based on easily available herbs and both metallic and organic compounds. Certain of its achievements have won occasional admiration from the highly advanced savants of the modern age.

Lay-out of the Village—The streets were broad. The Arthasasthra prescribes a width of 40 cubits for the main streets which were shaped like the 'back of the tortoise' to facilitate drainage. Each caste which pursued its own profession lived in separate parts of the village and it was surrounded by a common and free grazing ground. The land during the Hindu period did not belong to the King but to the people who occupied it; hence, perhaps, the traditional and great attachment to landed property which still exists.

The Professions—Each village had a class of artisans who were hereditary and being non-cultivating were given definite shares of grain at harvest. In return for this the farmer was entitled to the services of the artisans both for his household and agricultural needs. Whereas professions like that of the carpenter, the smith, the washerman, and the barber were definitely recognized and provided for in the village organization, the village Teacher was not in this category as literacy was not considered a communal need. Most villages had, however, a school Teacher who was maintained by voluntary presents from the parents of the children attending his school. During marriage and other important occasions, the householder thought it a privilege and honour to feast the Teacher and his whole band of students.

THE GREAT CHANGE IN THE VILLAGE

Self-contained and Isolated in olden times—To realize fully the present condition of the Indian village and understand its problems it is necessary to briefly notice here the changes that are coming over it and the reasons for that change. The Indian village of ancient times was practically a self-contained, self-governing unit, having but little contact with the outside world. It grew all the crops required to meet all its simple needs and the surplus of good years was stored in the village granaries as a provision against future unfavourable seasons. The people of the village lived like the members of a big family under the accepted leadership of the village elders—the Panchayatdars. Land was plenty, needs few and there was a great deal of contentment. The villager's outlook and knowledge were limited, rarely extending beyond the confines of his own village and the villager's life ran an even course from day to day. This had been the condition for well nigh two to three thousand years.

Drawn into world current—During the same period the West, on the other hand, was rapidly evolving itself from a condition even more primitive than that of the Indian village to that of modern times. Various inventions and discoveries had enabled man to gain partial mastery over his environment and both time and space had been largely conquered with the result that it is no longer possible nor desirable for any one to be oblivious of outside world events. The world is getting smaller and drawing closer together and an event in one part of the globe soon produces its repurcussions all the world over.

Dawn of the Spirit of Competition—The increase of population has intensified attempts to augment the available sources of food by opening up new lands where possible and the struggle for existence has brought to the forefront the idea of the 'survival of the fittest'. The spirit of rivalry and competition has sharpened the intellect in certain directions and the rights of the individual as such are getting increasing recognition. The religious impulse has steadily got into the background and has to wait the convenience of the other more urgent activities of life. Life has become more complicated in all directions. The code of conduct, which formerly was regulated by simple ten commandments, has now to be regulated by a whole army of learned lawyers and the ever growing volumes of law books.

Commercialization of crops—One very important result of the contact with the West has been the development of the export and import trades which have affected profoundly the kind of crops grown and both the occupation and mode of life of the village. It is steadily dragging him out of his isolation and throwing him into the world currents of commerce and industry. He is not content to grow crops to meet the needs of his own village but finds it more 'profitable' to grow what are termed 'commercial' crops for outside markets as distant as New York or London. This has upset the old time food centred economics of the village and is rendering them increasingly money centred. The more enterprising and intelligent of the villagers are attracted by the commercial life and tend to shift themselves to the nearest town or city temporarily in the beginning but often permanently in the end. It is no wonder that such great changes have brought in their train a variety of problems connected with our villages.

THE PRESENT-DAY VILLAGE

Dependent on Monsoons—As agriculture is the sole occupation of the villager its present condition and its effect on the economics and life of the villager are well worth consideration. One outstanding feature connected with Indian agriculture is its great dependence on the Monsoons. In spite of the great irrigation works—some of them the largest in the world—and the steady advance in the matter of tapping underground water, it has been estimated that seven eighths of our agriculture are yet dependant on the monsoons. Any one who has had to do with crop growing will realize how erratic the monsoons are both in time and quantity of precipitation. The unevenness and uncertainty of results in spite of his best efforts in the matter of cultivation and selection of seed, caused by factors beyond his control—such as drought, floods, and cyclones—render agricultural income unsteady and uncertain.

No Touch with Markets—Secondly, the villager is so little in touch with world markets wherein the results of his labours are evaluated and sold, that a large portion of his profits is intercepted by the intermediate agencies that market his produce. This is why the increase in the export trade has had comparatively little effect on the prosperity of the village as such. It is the towns that have chiefly gained from it. For the same reason there is but little adjustment of the crop areas to the prevailing market demands. A crop is often grown because it has been customary to grow it and not always because there is a demand for it. This results in occasional over-production quickly reflected in a fall in prices; and there is a time lag before its effect is seen in the contraction of area under the crop. This is an uneconomic and backward method of adjustment.

Stress of Population—Thirdly, land available for crop growing has not increased to the same extent as increase in population. True some new lands have been brought under the plough and yields from existing lands have increased somewhat, but such increase is much less than the increase in population. The prevailing sentiments, both social and religious, that directly encourage large numbers of children were definitely needed in the olden days of plenty of land and low population. These are obvious misfits at the present time when conditions are just the reverse. Industrialization is known to check rate of increase in population. Rice—the main food crop of India and China—is admittedly the most suitable for densely populated areas like the south east of Asia. It gives the maximum return of food with comparatively little manure and poor types of implement and cattle. The increase in population has proved beyond the capacity of even such a crop. This has introduced a spirit of competition instead of the mutual dependence and good feeling in the olden days of plenty. It has been computed that ordinarily agriculture alone cannot support more than 200 to the square mile. In parts of Bengal the stress of population is near about thrice that figure and all dependent solely on agriculture.

Fourthly, possibility of large augmentation in acre production is severely handicapped by a variety of causes such as subdivision and fragmentation of holdings and the prevalence of rigid social customs and religious sentiments which cause the waste of such valuable manures as night soil and cattle dung and adversely affect the business aspect of agricultural production. Both subdivision and fragmentation are inter-related to each other and result from the same cause, *viz.*, the mode of inheritance of landed properties as obtaining in both the Islamic and Hindu laws.

Subdivision of holdings—When land was fairly abundant and agriculture practically the only means of livelihood, it would appear but obvious justice on the death of the *pater* to divide the land equally among all the surviving members. At the same time there is a limit in size below which it becomes uneconomical to subdivide agricultural land. This bottom limit would obviously differ according to nature of soil, kind of crop grown, availability of assured water supply and other factors; but one possible correlating factor would be the area that could be commanded by a pair of oxen.

This continuous subdivision has been a long-standing feature and in certain parts has reached a considerable degree of fineness. It has gone so far as to divide the water of a well, each sharer being entitled to so many hours of lifting water from it. Dwelling houses are also sometimes divided along their lengths with obvious disadvantage to both the units in the matter of ventilation and other facilities. Such subdivision is said to obtain in other countries as well; in France the holding is sometimes reduced to a single vine or a single tuft of lucerne grass and this condition is said to prevail also in Switzerland, Japan and Germany. But the big and material difference lies in the fact that, whereas in those countries the divided holding is only part of the owner's means of livelihood, in India it is often the sole source for employing him all round the year. Small sized holdings up to a certain limit are not by themselves wholly bad; in Denmark and Switzerland some of the best types of agriculture are said to be associated with such holdings, but the other circumstances peculiar to our country render them uneconomical in our land.

At present this evil is to some extent counteracted by certain of the sharers emigrating to the nearest towns or to countries overseas. The Indian is, however, so much attached to his land, be it small and unremunerative, that he continues to own it if not forced out by other circumstances. Its possession is not always as a business proposition but as necessary for status. This leads to the evil of absentee-landlordism. In one of the villages in the Bombay Presidency, Dr Mann found that 36 per cent of the owners had thus gone out of the village.

Fragmentation of holdings—But perhaps a greater evil than subdivision is what is known as fragmentation. When one wishes to invest on landed properties he does so often by purchasing bits from different individuals and hence located away from one another. When this property is divided after his life time each sharer gets generally a portion from each of the bits of land and thus the holding of each sharer becomes fragmented. This system is practised in the interest of absolute equality in the sharing. Lands, as is well known, differ somewhat from one another and it is considered most equitable that each sharer should have a portion of each bit of land, however distant they may be from one another.

The prevailing sizes of such subdivided and fragmented plots of land depend upon the soil, kind of crop grown and nature of irrigation supply. They are smaller on the banks of rivers such as the Ganges, the Godavary and the Cauvery with their assured water supply and larger in the open rain fed plains of the Central Provinces and the Punjab. Small holdings are also characteristic of well-irrigated areas, where the lifting is through bullock power. Rice holdings again are smaller than those growing wheat as, in the former case, fields have to be divided into small plots and bunded up to retain the needed water for this semi-aquatic plant.

This state of affairs rules out large scale operations by outside capitalists who have the resources for up-to-date agricultural methods generally beyond the reach of the average cultivator. The number of landlords they have to deal with is too large and one recalcitrant can hold up a whole scheme. The value of large scale operations in raising agricultural efficiency has been amply demonstrated in other tropical countries like Hawaii, Java and Formosa. Certain of the sugar concerns in the Bombay Presidency which are launching on large scale growing of sugarcane are faced with such difficulties. Another disadvantage is that it precludes the fencing of the property, a valuable aid in raising agricultural efficiency. It is claimed that fencing of lands was one of the chief factors in greatly improving agricultural production in England after the Elizabethan period. The constant and unavoidable disputes resulting from these long and irregular boundaries lead to bad feeling between the villagers; and, it is said, that incendiarism of fodder stacks in the Bombay Presidency is often traceable to such misunderstanding.

VILLAGE CATTLE

The Aryan settlers loved their cattle and valued them highly. A grazing waste round each has been the standard feature of the Indian village; its width was fixed at 400 cubits during Chanakya's times and in the Moghul days it was as much as the human voice could be heard across. In Vedic times the wealth of an individual was computed by the number of kine and is so in parts of our country even to this day. Unlike China and Japan where the consumption of milk as food is considered a disgusting habit, this article has been highly valued in our land and extensively used as food from ancient days. This is fortunate for a country like ours which otherwise is largely vegetarian. Milk was not banned even in the case of the semi-recluse who was denied most other articles of diet. In the Brahmanical period the daily prayer included an invocation for the health and prosperity of the cow.

The cattle represents sometimes the heaviest capital outlay of the cultivator next only to land and he loves them almost to a fault. It is common in the Punjab to lay by, each day, a handful of 'atta' (wheat flour) so as to sumptuously feed the cattle on occasions; and it is considered an act of charity to lay along the roadside big pieces of rock salt so that the cattle can lick them on their way. A day in the year is set apart as cattle festival when they are decorated and feasted on sweet rice and cakes. In certain parts of the country like the Vizag and Bellary Districts of the Madras Presidency the cattle often occupy the front portions of houses.

But this very attachment and religious regard to the cattle—particularly the cow—is now working to their disadvantage. India is unique in possessing an enormous amount of cattle without making profit from its slaughter. The old and the weak are allowed to deplete the fodder stock of the village with the result that the fitter and hence the more useful ones do not get their due share. Cattle maintenance is not looked upon as a business proposition and the sentiment towards them is similar to that of a rider to the old horse which had served him well when he was fit and strong, or of the lady aristocrat to her pet dog or cat in the West. The sentiment is too deep-seated for a rapid change.

The Motor, the Oil-Engine, and Elcetricity are steadily replacing cattle power (largely of the male sex) for transport and water lifting. On the other hand, the demand for milk and milk products is likely to increase in the future and it is desirable it should be so. Fewer but better type of cattle and tended with greater knowledge of their needs, are indicated in the future. Castration in as painless a manner as possible to work out the uneconomic types from the village stock is the crying need of the countryside. The world is getting accustomed to such ideas even in the human species. With increasing knowledge of factors determining the sex of the fertilized egg will science be able to increase the number of heifers as perhaps in the future we might need more cows and less bullocks ?

VILLAGE LABOUR

For agricultural labour the Aryan colonists would appear to have employed largely the local people—the Dravidians and aborigines. Even in those early days agriculture was considered somewhat degrading as being non-intellectual. It has to be remembered that those were times when land was plenty—often perhaps virgin soils—and hence parted with its treasures more easily and abundantly than now. The agricultural labourer was employed more or less on a feudal basis and though the work was hard there was considerable affection between master and servant. The 'padial' system in parts of South India and the 'hali' system in parts of Bombay arose from labourers originally borrowing money against free service stipulated during the pendency of the loan but afterwards not being able to repay. He thus became a perpetual servant till released by death or emigration. The Indian labour is low both in wages and efficiency, certain extremist opinion equating a week's labour of the Indian to a day's of the Westerner.

But the demands of agriculture are such that, whereas at certain periods a large force of labour is needed, there is no demand during other parts of the year. This is particularly the case where the bulk of the area in the village is under the same crop. In the absence of work and hence wages all the year round, the labour migrates to other places with the result that, at the time of peak demand (as during paddy trasplantation) there is labour scarcity. Crops like the sugarcane which need labour all the year round, greater diversity of crops or subsidiary occupations are needed for stabilizing the labour demand.

THE VILLAGER AND HIS INDEBTEDNESS

Having briefly considered certain important aspects of village life, we are now in a position to consider the present condition of the villager himself. Though till recently but little affected by the changes around him, on account of his isolation both mental and physical, he is being made increasingly aware of the changes around by the extension into the village of such symbols of modern life as the Post and Telegraph, the bicycle, and the motor bus. Frequently also the village is visited by the townsman who is only too eager to demonstrate before the awe struck villager the elegances and conveniences of urban life. Himself a vestige of the past, he looks with wonder and admiration—and sometimes with fear—at these innovations which, on account of his little or no education, he is unable to comprehend fully.

Economically he finds himself in a very disadvantageous position owing to his steadily diminishing agricultural income in contrast with increasing expenditure due to changes in living even in his own household. Innovations in dress and habits and new wants like tea and coffee are steadily forcing up family expenses. While the community life of inter-dependence has ceased to exist, the medieval social structure like the joint family system still persists rendering the villager's life unbalanced.

Indebtedness—Dependant as he is solely on agriculture, the need for money always exists. This is true of the agriculturist all the world over and results from the fact that, whereas agricultural income comes in only at particular times like harvest, his expenditure is of a monthly if not of a daily nature. Extra profits from an exceptionally good year are more often wasted in urbanizing his surroundings than being put by as reserve against lean years. The heavy indebtedness of the Indian villager is well known and has attracted the attention of all that have cared to study the village. In one village studied by him and his colleagues Dr. Mann found that the total debts of the village amounted to about 12 per cent. of its capital value and that nearly 25 per cent. of the profits of the village went to pay interest thereon. According to Mr. Darling, debts in certain Punjab villages amounted to as much as Rs. 40 per acre, a sum sometimes greater than the annual income from it on the average of good and bad years.

The villagers' debts are also often unavoidable. It has been calculated that nearly 90 per cent. of a villager's expenditure is on such essentials as food, clothing, rent, and taxes, thus leaving but little margin for unexpected reverses such as crop failures or floods or sudden cattle mortality. Expenses on marriages and funerals, which to the villager are equally unavoidable because of his traditional ideas, are other sudden items of expenditure. The margin of extra income is so narrow that the loss of a buffalo or the long illness of the working member in the family is known to drop the villager down in the social scale sometimes never to recover to his original position. The only security he can offer against such debts is the land, his only possession in this world, and once pledged he finds it difficult to redeem it.

Village wastes—While on the subject of the economics of the villager it will be appropriate to consider here the various types of waste that are taking place in the village. Foremost, perhaps, is the agricultural waste resulting from the uneconomic subdivision and fragmentation of land which precludes its cultivation to maximum benefit. Then come the waste of cattle and human labour due to fragmentation, the drain of village money by way of interest on loans raised by the villagers and loss of valuable manures like human and cattle voids. Cattle manure is wasted as it is needed for fuel. It is such a suitable fuel in the Indian household that a substitute alone will be operative in bringing about its rapid discontinuance as fuel. Human voids instead of being utilized as in China and Japan, are allowed to render the streets and surroundings unsanitary and poison the clean country air. There is considerable waste of both energy and material resources through adherence to sentiments and habits which, perhaps useful in olden times, are useless and wasteful under the changed conditions of to-day.

One important waste which has to my mind far-reaching results is that caused through forced idleness. This is because agriculture, which is often the sole occupation, is not able to keep the villager busy all the year round. This forced idleness is very harmful, changes his whole outlook on life and lowers his character in many ways. No tonic is so good as healthy and steady work all through the year and this is denied to the average villager. The comparative prosperity of villages located near towns or industrial centres proves the advantages of employment all through the year.

Standard of life—One common complaint laid at the door of the Indian by others and of the villager by the townsmen is what is termed 'low standard of life.' There exists, however, considerable confusion as to what the term really means and though it is but vaguely understood, it is nevertheless readily resorted to, when there is no room for sound and logical reasoning To put it briefly and in easy language, a higher standard of life may be defined to consist in getting more out of life's opportunities to the advantage of both the individual and his society. A rise in the standard of living must add to the productive efficiency of the individual or it is no HIGHER though it may be a DIFFERENT standard. All real progress and civilization is interpretable only on this basis. But when a townsman, weak in physique through wrong and unsanitary living, with a diversity of unnecessary and unhealthy wants and unnecessarily and perhaps also harmfully dressed, talks of his higher standard it is an obvious misapplication of the term. It is a case of a more EXPENSVIE and not HIGHER standard of life. A healthy cultured villager with his fewer and simpler needs but greater depth of character is easily the superior.

The merchant, with his desire for commerce, has a tendecy to synonymise 'higher standard' with 'increased wants and greater purchasing power.' While an increase in wants as the result of a fuller life—such as books, works of art or facilities for quicker locomotion—does represent a higher standard, it ceases to be such when the increased wants are unnecessary, wasteful or harmful to the individual or society.

THE EXODUS FROM THE VILLAGE

The most serious of the unfavourable changes coming over our villages is the steadily increasing exodus of people from the village to the town. There is little doubt that the villages were comparatively more populous in the olden days. The Arthasasthra contemplates a normal population of 500 to 1,500 against the present average of about 400. One main reason for this exodus is the growing inadequacy of agricultural income not supplemented by income from other sources. A second reason is the shifting of the main activities of life to the town. Educational facilities and other urban conveniances are increasingly attracting the villagers to the town. Dr. Mann was struck by the significant absence from a Bombay village of youths between the age of 14 and 20; and this is largely true of other provinces as well. They had gone out for education or to seek employment. When a person has lived in the town for some time he often develops a dislike for village life with its limited comforts. He misses in the village various things to which he has become accustomed in the urban surroundings; he misses the rapid means of locomotion, the quicker life of the town, the facilities for shopping, the pictures and the like. He finds a comparative dullness in the village surroundings which makes him loath to return to it.

Apart from the number, the quality of human material contained in the exodus constitutes a serious drain. Take, for instance, a family of four sons all of whom had gone to the nearest town for education. The sucessful ones get employed away from their villages in due course and rarely return to it except if at all in old age. The unsuccessful ones, on the other hand, with nothing else to do perforce return to the village and settle there, thus increasing the pressure on the land often disproportionately to their contribution to the village assets. Secondly, the richer landlords who, by their superior resources, could, if they care, undertake experiments or launch fresh agricultural ventures, are attracted to the town and leave behind in the village their less resourceful brethren. Similarly, the capable artisan leaves for the town to make the most of his talents. Culture is now town-centred and there is little scope in the village for the full development or unfolding of one's talents. In the olden days when the village was practically autonomous and had its own funds to cater to the needs and amenities of the village the opportunities in the village were greater, and it was possible to retain in the village at least a portion of the intelligentsia, though even then the best of talents resorted to the capitals or courts of Kings for patronage.

Rural Life and Agriculture in China

The one country in the world whose conditions of rural life and agriculture are similar to our own is China. That country presents many points of similarity with ours and a few contrasts.

The Chinese also have a civilization as old as ours and in ancient days there was a certain amount of contact between the two nations. The national religion of China had its origin in our land and the Chinese sent out an industrial commission to Bihar as early as the sixth century to learn the process of sugar manufacture. The two Chinese travellers to our country, *viz.*, Fa hien (399-414 A. D.) and Hiuentsang (629-645 A. D.) and their writings are well known. Like its Indian prototype the Chinese village also has been isolated from world changes and the bulk of the people in that country also live in villages and hamlets. They lead a comparatively simple life and their holdings are small. Density of population in China is greater than ours, their agricultural implements primitive and most systems of land tenure existing in our country are to be found in China as well.

But the Chinese are specialists in small scale farming and are adepts in taking the maximum from their lands. They have made the conservation of human voids for manurial purposes almost a fine art, and their agricultural operations are so intensive that they often raise a multiplicity of crops on the same land. By an extravagant use of human labour which is highly intelligent and cheap, they make for want of efficient tools and scientific equipment. They possess unusual gifts for quality production. We in India are familiar with the peripatetic Chinese silk merchant with his large bundle of silk pieces strapped to his back—a symbol of hard work and perseverance. Human labour is chief in China and, in spite of the existence of modern cotton mills, some of the spinning and a great deal of the weaving is still carried on in the villages as cottage industries. Like us they are also now faced with the sudden inrush into the villages of western achievements and organization and the solution of our common problems would probably have to be on parallel lines.

Villages in Other Lands

Danish village—The villages in Denmark are good examples of what co-operation, education and the linking of agriculture with other industries carried on in the village itself can achieve in the development of small scale farming. The subsidiary industry in this case centres round the Cow and its products. During the decade 1880-1890 the Danish villages were in a bad way from the effects of the aftermath of the Napoleonic and Prussian wars; and there was manifest a tendency for the people to leave the village for the town. In that decade the increase of population in urban areas was 325 per 10,000 against the corresponding figure of 21 for rural areas. But by the quinquennium 1901-1906 conditions had so altered through organization and rural amelioration work that the figure rose to 99.

Holdings in Denmark are comparatively small, most of them being not much more than eleven acres. The farmers effect all their purchases and sales through properly federated co-operative organizations and thus get the benefits of large scale transactions. The Cow is an important factor in rural Denmark and aids the agriculturist with steady supplementary income. Sons of farmers get regular training as apprentices before being allowed to take charge of farms. In our country, on the other hand, farming is the one occupation which is not considered to need any training. Such apprentices are said to constitute the chief labour in certain of the Danish farms. Every farmer is educated and well posted with regard to market trends and prices. He lives in a clean house with a well built outhouse for his cattle, the whole often forming a quadrangle with a neat garden in the centre.

The State helps in the development of efficient small farms. When a candidate satisfies the local commission that he is fit, possesses knowledge to run a farm and also produces a tenth of the capital, the State finds the other nine-tenths and no repayments need be made during the first five years. The farm is to be redeemed in the course of a hundred years and during this period the unit is neither to be mortgaged nor subdivided. It is said that about 50 per cent. of such farmers have made a success, about 30 per cent. are just getting on and the rest failures. Such small farms—with the products of the cow as the subsidiary industry—are said to have proved more efficient in adding to national wealth than capitalistic farming on a large scale.

Swiss village—A sense of absolute justice and fairplay is said to be the outstanding characteristic of the Swiss villager and this, it is said, has made Geneva the logical seat of the League of Nations. The Swiss farmer also depends a great deal on the Cow which he duly insures. They have accident and harvest insurance companies and State insurance against unemployment. The villager commands all modern conveniences like electricity in his village house and every farmer makes his own wine as a cottage industry. The government of the village is vested in a Council who do the work in an honorary capacity.

THE FUTURE OF THE INDIAN VILLAGE

After this rapid review of the Indian village in the past and the changes that have been coming over it up to the present time we are now in a position to consider its future. There is little doubt that the general tendency so far has been for the village to steadily go down in prosperity and importance in contrast to the town which has increasingly drawn the best from the village. The question to consider is, if this is in the best interests of our country and, if not, are any steps needed to place the village in a better position than now. Does the future lie in a greater and further development of urban life, evolving measures that would somewhat mitigate the inevitable disadvantages associated with it or does the situation need radical changes in the village and village life, importing into it certain characteristics of the town ?

In spite of its having become trite, the statement that ours is an agricultural country warrants repetition on account of its far-reaching effects on all our activities. The plough with a pair of oxen is perhaps the one symbol that would properly represent India as a whole with its different classes and communities. Secondly, the rapid increase of population in our country and China has become a byword and this renders incumbent a further increase of agricultural production. Science has so far not succeeded in growing crops on the roofs of houses or on road-sides in towns and the best achievements of agriculture have been in the countryside. The clearly indicated line of advance for the future, therefore, lies in improving rural conditions and rendering our villages better and more efficient in the discharge of duties set to them by the country as a whole, viz., (1) the proper and adequate feeding of the steadily increasing population, and (2) rearing a healthy stock of men and cattle and maintaining them in a fit condition.

Both town and village are needed for the full and complete development of our country as a whole. The town is a natural and inevitable product in this development. 'If God made the country' the town was and is being made by man, His agent, and in response to forces no less natural in the broad sense of the term. Ours has been and still largely is a land of villages but the towns have risen up and are bound to multiply and expand in the future. In recent times there has been a growing tendency to centralize culture and activities in the town to the disadvantage of the village; and the towns and cities have in a sense grown at the expense of the village.

But each has certain specific advantages and inevitable defects. In crop growing, when one comes across two types both of which possess desirable characters, the crop servant—called the Breeder—tries to raise hybrids between them for producing kinds which might combine in themselves the good points of both and eliminating as far as possible the defects of either. This process of hybridization is neither new nor recent. Nature has been doing this since the beginning of life and the existing crop types are the result of such so called 'natural' hybridization and selection. A similar procedure is indicated between the town and the village and such a process is already in progress. The open air extensions that have grown round towns in recent years—with compound houses and gardens—indicate the attempt to ruralize the town in the matter of health and surroundings, while the Post Office, the rural dispensary, the school, and even the bus horning its way through village are in the nature of urbanizing the countryside. Suburban colonies also represent such an endeavour to combine the advantages of both country and town life. While the process is already in action it is desirable to speed it up by conscious endeavour.

IMPROVING AGRICULTURAL EFFICIENCY

Elsewhere we have considered certain serious handicaps the present-day village agriculture is labouring under. Thanks to the good work inaugurated by Lord Curzon's Government about thirty years ago reinforced and supplemented by the elaborate and far-reaching recommendations of the ROYAL COMMISSION ON AGRICULTURE of 1930, we are now in a position to feel that technical advances in agriculture and allied sciences can be taken to have been provided for. The Imperial Council of Agricultural Research, a lusty child of the Royal Commission, has already won back to us a major industry and is engaged in grappling with problems of fundamental importance like marketing.

While on this point I cannot resist the temptation to refer to the outstanding achievements in the breeding of valuable crop types. Our most rapid and effective advance in agriculture has been along this line and to-day almost every crop is being systematically bred all over the country. Advance in this direction—viz., the improvement of crop type and distribution of its seed—has been the most suitable to our present conditions of comparative poverty of resources in other directions. For the production of these types the resources in the way of plant material of more than one country has been and is being systematically employed. Combined with substantial Tariff protection afforded by a kind Government, it has resuscitated our sugar industry and thus saved a drain to the country of 15 crores of rupees per annum on the average. It is employing a hundred thousand additional labourers in the factories and about 1,500 graduates in these days of unemployment besides the five million extra agriculturists directly benefiting from it. This demonstrates the great value to the country as a whole of industries founded upon our own agricultural products.

That it is possible to augment the agricultural income of the villages to a considerable extent is evident from the fact that even in the West, which is much more advanced in this matter, the opinion is held that further marked advances are possible. A recent theoretical calculation has shown that, under the best of conditions and with the needed machinery and organization, twelve able-bodied men are sufficient to culivate 365 acres of sugarcane and from it supply the carbohydrate needs of as many as

14,500 men and that thirty-five individuals could be fed from the produce of one acre, if properly handled. It is true that these calculations are somewhat theoretical as they assume conditions which do not exist and which it may be difficult to fully materialize, yet they are useful indicators of possibilities in the direction.

The evils resulting from subdivision and fragmentation of holdings have already been noticed. These are beyond the capacities of technical departments to remedy, however earnest or well organized they may be. They are caused by ideas and sentiments deep-seated in peoples' minds and legislation is the only remedy. It is a matter where we have to help ourselves and submit to certain hardships in the interests of the country as a whole. Other countries have shown the way. In Austria the economic holding is recognized by the law of the country and is both indivisible and unmortgageable (except for short periods). In Italy such holdings are said to be inalienable, indivisible, and unseizable. In Denmark a law passed in 1837 provides for the proprietor leaving his farm intact to any one of his children and providing moderate consideration for his other heirs. It is gratifying that certain Provinces have initiated action in this direction.

Literacy and education.—As the efficiency of any programme of rural improvement depends primarily on the Chief Agent in it, the Villager, it is important to consider means for increasing his efficiency. If we compare the Villager with the Townsman one point in which the latter often scores over the villager is his literacy if not always his education. This is not the place nor is it necessary to detail the various advantages of education or even literacy. Suffice it to say that even in elementary education we have a very effective weapon for bringing the villager out of his narrow horizon, breaking down his superstitions, placing him in touch with the rest of the world through the printed word and for facilitating the introduction of various reforms for his betterment. In the progressive evolution of the human species acquisition of certain characters such as the 'erect habit' are credited with having introduced far-reaching effects. Education belongs to this category.

Though it is true that the village Teacher did exist in the olden days and at least certain classes of the population received some kind of school and even higher education and though there is evidence that reputed universities did occasionally flourish in certain rural parts, regular schooling and education were not considered essential. While, according to the Arthasasthra, the Sukranithi and the Manusmrithi, the carpenter, the blacksmith, the shoemaker and in certain cases even the astrologer were definitely recognized in the elaborate village organization, the school-master did not occupy such a position. It was left largely to the priest class or some men of learning to give instruction in the three 'R's' and take the more advanced students even higher up the scale in return for voluntary gifts from the parents of the boys in their charge.

Education given in the village school should obviously possess the rural and agricultural outlook and be vitally linked with the every-day life of the village. In our boyhood days we learnt more about the geography and history of places we could never hope to see while being comparatively ignorant of our own district and its environment. Such an important subject as the anatomy and physiology of the human body was reserved till the student had mastered the various distinguishing characteristics of the metals and the nonmetals or the names of the then two important towns in the Sahara region. There is now a steady and welcome change in this matter. Nature study lessons fit in well with the agricultural life of the villager and I have often wondered why the village vacations should be timed to the conveniences of metropolitan examinations rather than to the busiest agricultural seasons in the village when the boys could perhaps help their parents in the field and gain firsthand knowledge of subject taught in the school-room.

Intellectual alertness.—A second characteristic of the Villager as contrasted with the Townsman is often the slower moving intellect of the former. This is not mentioned here in a derogatory spirit; the difference is due to difference in the environment. The every-day struggle with the great forces of nature develops a deeper character in the villager, but in intellectual alertness he is often inferior to the townsman. Agricultural operations are generally on the broad land and hence the workers are in comparative isolation, whereas intellectual alertness is greatly accelerated through contact and clash with other minds, a feature of industrial life. The rather extreme opinion has been held that most agricultural improvements themselves have been from men whose intellects have been sharpened by industries and commerce. The linking up of villages with towns and other villages, through better communication facilities, for instance, will remedy the situation.

Business habits.—Yet another common defect of the villager is the lack of so-called 'business' habits and 'business' mentality. This again is due to his environment and tradition. Nature's processes with which the Village Agriculturist is primarily concerned do not generally need the punctuality of the man of business or commerce. The cow in insured both in Denmark and Switzerland on account of its importance in rural economics. The absence of insurance measures in our villages against crop failures and cattle epidemics, which are by no means uncommon, is largely attributable to the absence of education and business outlook. The villager's income would be both enhanced and rendered steadier by the import of the 'business' mentality into his activities such as agriculture and cattle maintenance.

Outlook on life.—The villager's outlook on the world is often narrow because of the isolation and the absence of literacy. Whether he likes it or not, the villager is being dragged into the world currents of commerce and industry and his horizon needs to be broadened by education. His constant fight with forces of Nature over which he has little control, tinges his ideas with almost fatalism. A bad season too often disproves to him the truth in the saying 'As you sow so you reap'. Industrial activities, on the other hand, are associated with processes which demonstrate the control of natural forces by man and this has a tendency to develop in him certain amount of self-confidence, it not of human pride.

COTTAGE INDUSTRIES

In this study of the Indian village, the villager and village life, we have frequently noticed the need and advantages of industrializing the village. We have found that industries are desirable in the village to find employment for the people all through the year, to stabilize labour, to tone up the villager in various directions and to supplement and steady his income. The large scale industries, which have developed in the country—while both useful and important for the progress of the country as a whole—have helped the villager but little. On the other hand, they have adversely affected the village tending to draw labour and brains away from the village. What is needed is the establishment of cottage industries in the village itself so as to improve the conditions for living in it.

It is obvious that the closer such industries are linked up with agriculture and agricultural products the better they would fit in with village economics. Cattle being an important adjunct of agriculture, industries like cattle breeding and production of milk and milk products at once suggest themselves. The value of cattle for agriculture is not confined merely to its use as labour, but the trend of recent work is indicative of their playing a very important part as the store house of the right type of manure for crops. The animal and plant kingdoms would appear to be the counterparts of one unit, each benefiting from the waste products of the other. Bee keeping, the poultry industry, fruit growing and canning and preparation of tinned and infant foods for the benefit of the townsman would fit in well into the village.

Other suitable industries would be the partial preparation of manufactured products in the village itself as a rural industry. Cotton ginneries, seed decorticators and oil presses belong to this group. It saves in the transport of raw material to the central factory, the half-prepared material being generally less bulky than the original raw product. The transport to the village of the bye products of manufacture, such as seeds in the case of cotton which are needed back in the village both for sowing and as cattle food, is also thus avoided. Minor industries connected with products or articles available in the village or vicinity, such as cocoanut industry in the West Coast and fish curing in seashore villages, help to keep the villages prosperous.

Other handicrafts and domestic industries, where the needed material is imported from outside and worked in the village during the off-seasons, include weaving, dyeing and the manufacture of toys and trinkets. In spite of technical advances there are yet certain industries which lend themselves to be worked in the villages as domestic industries. The manufacture of toys in the Black Forest regions of Germany, watches in Switzerland, cutlery in Sheffield and little fans, flower baskets and ornamental pieces in Japan are of this class and are a great help in supplementing and steadying the villager's income. The mechanical efficiency obtained in the village as the result of such rural industries gives the village a 'mistry' class who should prove increasingly useful in the repairs and upkeep of farm machinery and water lifting pumps which are spreading in the country.

Co-operative Organization

The value of organizing on a large scale for increasing efficiency is well known and widely accepted. Most village activities, on the other hand, have by their very nature to be on the small scale and their being grouped together through co-operative organizations is the only remedy. Through them even the small farmer and producer is enable to command facilities and advantages generally available only to large scale units. The purchase and sale of articles connected with cottage industries, for instance, need grouping together through co-operative organizations for best results.

There was apparently a great deal of the 'mutual help' and co-operative spirit in the villages of old. Certain of these are surviving to this day in the form of customs or usages, sometimes transmuted into religious observances and thus commanding unquestioned obedience. In the remote countryside marriage or death in a family is often a village event and is shared by the whole community even in these days. Guests at marriage functions come in with a variety of contributions including provisions for the marrige feast. The inhabitants of a street are forbidden to take food till the dead is removed and properly disposed of and food for the bereaved family is provided by other villagers for the first two days. The spirit needs to be revived and placed on new lines consonant with the modern age.

Amenities of life

As a class our villages lack the conveniences and amenities of urban life. While perhaps certain of these might be considered unnecessary and a few even harmful, there can be no doubt that the bulk of them are in tune with and are necessary for modern progress which is taking hold of the world whether we like it or not. Conveniences like means for rapid transport, the Post and Telegraph, the Newspaper and the ever-increasing improvements associated with the development of electricity are major blessings which it is desirable should be extended to the villages as quickly and as completely as possible. It is the absence of these in our countryside that is partly responsible for the prevailing distaste to village life. The village is easily healthier than the town in such important factors as pure air and open spaces and if only certain urban facilities are implanted in the village, its attractions for settlement should prove irresistible.

The general tendency for retired Government officials not to return to the village but settle in a nearby town has struck me as unfortunate and is indicative of the general trend. While in certain cases perhaps the decision might be due to urban educational facilities, there is little doubt that the general unattractiveness of village life also enters into the decision. For permanent results the urge for rural improvement should be implanted in the village itself. This could be achieved only by improving the chief natural Agent in such work—viz., the Villager—and making it attractive for him to live and have his being in the village itself. Endeavours that are town centred and take to the village for temporary periods, for lectures, demonstrations or shows—however honest or energetic—have an outside flavour to the villager and do not, therefore, get permanently assimilated into village life.

CONCLUSION

To sum up, there is little doubt that the villages of old were more populated than they are to-day largely because of conditions prevalent at the time. Those conditions will never return however much or sincerely we may hanker after them. The town and the characteristics associated with urban life are definite products in the march of events and need to be accepted as such. Though there are drawbacks associated with urban life the town has its own good points which need extension into the village to keep rural life in tune with the changes around us. At the same time, the countryside has advantages like open spaces and absence of congestion which can never be reproduced in the town.

Life activities that were village centred in the past are increasingly getting town centred to the disadvantage of the former. In the interests of the country as a whole relationship of mutual help needs to be established between the two. The town should extend to the village its greater knowledge, quicker living and the manifold amenities of the modern age. Contributions from the countryside are of equal importance. It alone can produce the raw materials of commerce and industry and thus help in the growth of towns and cities. It alone can supply adequate and wholesome food to the millions of our land whether resident in the village or town. Lastly, the country-side alone can imbue the urban 'business' civilization with the deeper character and larger humanities which are nurtured in the villager through his more direct and constant contact with the great forces of Nature and of life. Our duty then is clear: Namely, to improve the *Village*, the nucleus of our country life, and infect its Chief Agent, the *Villager*, with chosen culture of the virus of modern age through ***Education*** and ***Industrialization.***

SCIENCE AND CULTURE

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The Irvine Committee Report

THE Government of India has released for publication the report of the Quinquennial Reviewing Committee of the Indian Institute of Science, Bangalore, which was presided over by Sir James Irvine, F. R. S., Vice-chancellor of the University of St. Andrews, Aberdeen (see the *Gazette of India*, Nov. 28, 1936). For the benefit of our readers we are giving a short review of the report and the action taken thereupon by the Government of India. The reader may refer to our earlier editorial on the Indian Institute published in March 1936.

The public press has taken the appointment of this Committee as a censure on the present Director. Such an impression is due to ignorance, for, according to the rules and regulations and statutes of the Institute, the Governor General-in-Council has no option but to appoint a Reviewing Committee every fifth year. In the present case, the Council, under suggestion from the Director, passed a resolution (which was carried against a strong minority), asking the Viceroy not to appoint the Reviewing Committee. But in making this request the Council had transgressed its powers, and the action of the Viceroy in refusing the request and appointing the Committee was a well-deserved rebuke to the Council as well as to the Director.

Our impression is that the Irvine Committee's report is a very well-considered and well-balanced document and we are glad to note that its main recommendations have been accepted by the Council and the Government of India. We may now hope for a period of stability and progress for the Institute.

The report is divided into three sections: (1) Part I reviews the *present administration* and deals with the questions of policy and administration, (2) Part II deals with finance, and (3) Part III with specific problems affecting the Institute. We shall here confine ourselves to a discussion of Parts I and III.

Policy and Administration of the Institute

In our editorial mentioned above, we gave a review of the aims and objects of the Institute and we expressed our fear that "in spite of the warning of the Sewell Committee and in violation of hopes raised by the Director himself in the minds of the Indian public, the Institute is being taken away from its original ideal by undisguised academization of its activities" and by subordination of the interests of other departments to those of the newly established Department of Physics. The Irvine Committee says:

"The Institute has been persistently criticized on the ground that its main energies have been devoted to purely scientific research and that in consequence it has proved to be of little service to industry; indeed the idea seems to prevail that contact between the Institute and practical affairs is non-existent, or at the best is negligible, and that for this state of affairs the Institute alone is to blame. An impartial examination of the facts leads us to the opinion that the fault does not rest exclusively with the Institute which has endeavoured, with a measure of success, to investigate such industrial problems as have been submitted to individual departments.

> "...It appears to be well established that applied research does not receive the sympathetic support of the Director and that on occasions such work has been discouraged and disparaged by him.. It is not an exaggeration to say that the resources of the Institute are now being concentrated in the direction of research in pure physics, and that an atmosphere has been created within the Institute and, more publicly, through the agency of the Press, which is designed to place such research at a premium. Under these conditions applied research cannot possibly flourish, and unless our recommendations are adopted promptly, there is little doubt that the Institute will soon lose even the slender connexion with industry which it still retains.
>
> "...The active prosecution of applied research should be regarded as a duty, willingly undertaken with the certain knowledge that the more energetically this duty is fulfilled, the less scientific prominence becomes attached to the workers themselves. Few publications are likely to result from such research work, but this need not be deplored if in the end the Institute is made to play the part for which it was created."

These findings show that SCIENCE AND CULTURE did a service to the country by pointedly referring to the deplorable state of affairs at the Indian Institute, and the Irvine Committee did practically accept all suggestions made in our editorial; yet our London contemporary, *Nature*, which forms its impressions from a distance of 5,000 miles, stigmatized this article as *untimely* !

The Ideal of the Institute

The ideal of the Institute is laid down by the Irvine Committee as follows :-

> "We are fully alive to the advantages and the cultural and material benefits which accrue from fundamental scientific work; equally we recognize that there is no conflict between pure and applied research which can be, and ought to be, prosecuted side by side to their mutual advantage. We are chiefly concerned with the problem as to which of these complementary activities should carry the greater emphasis, and we hold strongly the opinion that, in accordance with the wishes of the Founder, this emphasis should be laid on the applications of scientific research to industry. Accordingly, our first recommendation is that Clause 3 in the Regulations be amended to read as follows :-
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> "The object of the Institute shall be to establish Chairs in Science and Arts for the purpose of providing advanced instruction and conducting original investigations, in all branches of knowledge and particularly in such branches as are likely to *promote the material and industrial welfare of India* ; to provide suitable libraries, laboratories, and equipment ; and to co-operate as far as possible with such recognized institutions as exist or are founded in future for cognate objects in India."
>
> The adoption of the above regulation will remove ambiguity as to the purpose of the Institute, will enable a continuous policy to be followed, and will inspire confidence in the bodies which assist its finances. As will appear later in this Report, we do not recommend the curtailment of fundamental scientific research or the abolition of teaching ; but in terms of the regulation now proposed, teaching (except in the case of Electrical Technology which stands in a special position) should be confined to preparing workers as investigators and, while research in pure science should continue to be an approved purpose, *the major part of the resources of the Institute should be applied to those investigations which are likely to be of direct benefit to industry in India*" (italics ours).

False Ideas regarding the Capacities of the Institute

The Irvine Committee has justly pointed out that great confusion exists in the public mind regarding the capacity of the Institute. It says :—

> "The evidence before us shows that in some quarters it is tacitly assumed that the Institute should be capable of searching for and selecting industrial problems, of solving these problems in the laboratory, and finally of applying the results on a technical scale. Such an attitude of mind is by no means confined to India, and so long as it is maintained the Institute will remain the target of uninformed criticism. It must be remembered that, judged by the standard of modern research organizations in Europe and America, *the Institute is small* and has to work within a comparatively narrow income."

The total income of the Institute is 5.47 lakhs of rupees, of which Rs 95,000 is proposed to be spent on administration. This leaves only four and a half lakhs for the work of the Institute and of this amount about 1.25 lakhs are spent on electrical technology, which combines actual teaching with research. The amount spent on research in physics, chemistry, and biochemistry is barely 3.50 lakhs. It is a very modest sum even on an Indian standard. Even a small university like that of Allahabad spends 3.50 lakhs of rupees on its science departments (almost wholly on teaching and research) and the University of Calcutta spends over its science departments a far larger sum. This should dispel the idea that the Institute is capable of doing wonders or has got a unique position in the country—an idea which has been disseminated by interested persons; and as a matter of fact, not many Indian universities will admit that the total research output of the Indian Institute has so far been comparable to theirs either in quality or quantity.

Review of the Administration

The Sewell Committee in 1931 recommended that the Director should be relieved of his routine administration by the appointment of a whole-time Registrar or personal assistant. This recommendation was accepted by the authorities and in 1932 when the present Director, Sir C. V. Raman, took charge, the Council sanctioned the appointment of a personal assistant in deference to the wishes of the new Director. This arrangement did not apparently work well. The Irvine Committee has recommended and the Government has accepted that the main administration work should be carried on by a Registrar *responsible to the Council and the Senate;* the Registrar has been given so wide powers* that one finds that almost little or no administration work has been left to the Director excepting a seat in the Council. Under the present rules, he will be merely head of the Department of Physics with no right of interference in the matter of administration of the departments.

It is a very sound measure and has our heartiest approval. If this measure were carried out five years earlier as recommended by the Sewell Committee, much of the present trouble would not have arisen at all. But wisdom comes only by experience! The creation of the post of Registrar makes the office of the Director absolutely redundant, and it were well if the Committee pursued its arguments to their logical end by recommending that after expiry of the term of the present Director, the post be abolished, and a Dean be nominated by the Council from amongst such heads of departments as have attained the rank of Professor.

The Irvine Committee has very few good words on the administration of the Institute by Sir C. V. Raman. "Referring to the personal relationships between the Director and the staff," the Committee, on a thorough and impartial examination of the whole situation, found, "a disquieting state of affairs," and it is their "considered opinion that unless firm action is taken at once, the future of the Institute is exceedingly precarious."

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* The appointment of a Registrar on a scale of Rs 800-50-1,000 is strongly recommended by the Irvine Committee to look into the administrative side of the Institute, "to restore harmony in the administration and a feeling of confidence in the staff." His allegiance should be to the Council and not to any department. The duties such as his can be carried out only by a man of mature experience and trained in official administration. "But his conditions of service must be such that he will be able to carry out his duties without any apprehension that if he discharges them fearlessly, impartially, and honestly, his prospects or the security of his position will be affected." The Committee has therefore strongly recommended that the Government of India be asked to arrange for the loan of a Government officer to act as Registrar of the Institute, his pay and leave and pensionary charges being paid by the Institute. His duties should include, as essentials, the following :-

(*a*) To act as Secretary of the Council, of the Senate, and of the Finance Committee, to prepare the agenda for the meeting of these bodies, to draft the corresponding Minutes, and to make such communications to the Press on Institute affairs as the Council alone may authorize.

(*b*) To conduct the correspondence relating to the business of the Council, to the Senate, and of the Finance Committee, including all correspondence referring to new appointments, elections to the Council, and the entry and recruitment of students.

(*c*) To receive enquiries and communications regarding problems of applied research submitted to the Institute and to place them before the Senate for disposal.

(*d*) To be responsible for submitting the draft budget to the Senate, the Finance Committee, and the Council for ratification.

(*e*) To perform such other duties as may be prescribed by the Council.

"The Committee appreciated highly the progress made in Physics, but evidence quickly revealed the fact that Physics was in process of becoming the dominant feature of the Institute, while the Departments of Chemistry remained understaffed and were in consequence losing ground. This shift of the centre of gravity from Chemistry to Physics—an inevitable consequence of the leadership the Institute now enjoys—is something which is not in accordance with the policy which should be followed in an institution founded, as we maintain, to promote the industrial welfare of India."

"...The Director's policy is to make the Institute a centre for physical and mathematical studies. True, there has been no suggestion that other departments should be suppressed, but as time goes on they will inevitably become more and more subordinated to physics until their individuality is to all intents and purposes extinguished. It may be urged that the heads of departments have shown little stamina in defending the interests of their departments. But it must not be forgotten that officers of professorial rank hold only short-term appointments and are in consequence placed in a difficult position if their views clash with those of the Director whose office is on a more permanent basis. Moreover the Director is the Chairman of the Senate and not only composes Minutes of that Body, but submits them to the Council on which he is the sole representative of the staff. The allegation has been made that the findings of the Senate have been misrepresented in their transit to the Council, and that letters and memoranda addressed to the Director on competent matters remain unanswered. *There can be little doubt that an atmosphere of insecurity and misery has been created* (italics ours).

"Making full allowance for possible exaggeration, *we greatly fear that there is much truth in these allegations*. (Italics ours). The resignations of Professor Watson and Professor Mowdawalla can now be readily understood, and if present conditions are permitted to continue it will be no easy matter to find men of character and independence willing to fill future vacancies."

Reorganization of the Institute

The Irvine Committee has recommended the reorganization of the Institute on the following lines :

There should be four departments, *viz.*, the departments of Physics, General and Organic Chemistry, Biochemistry, and Electrical Technology.

Under the régime of the present Director, the Department of Chemistry was well-nigh abolished. Under him the Department of Physics was started and fed at the cost of other departments, especially the Chemistry Department which was made to starve to an alarming degree.

"One example of this tendency which may be quoted, and it does not stand alone, is the transference of apparatus from the Department of General Chemistry to the Department of Physics where certain researches are now grouped under the heading "Chemical Physics". (Irvine Committee Report).

The Irvine Committee says with regard to the policy hitherto pursued in respect of the Chemistry Department :

"Not only is Physical Chemistry threatened with extinction, but the future of Organic Chemistry is likewise in jeopardy if recent decisions of the Council are carried into effect. It has been decided to send the Acting Professor of Organic Chemistry on study-leave for a period of nearly two years and, if past experience is a guide, we fail to see how any suitable arrangement, temporary or otherwise, can be made to safeguard the interests of this important subject during his absence."

In the opinion of the Committee, therefore, a strong representative school of chemistry, capable of playing a significant part in pure and applied research, requires chairs in the following divisions of the subject :-

(*a*) Organic Chemistry.
(*b*) Physical Chemistry.
(*c*) Inorganic and Mineral Chemistry.
(*d*) Technical Chemistry.
(*e*) Pharmaceutical and Medicinal Chemistry.

As under the present financial conditions of the Institute, it is not possible to create a full professorship for each of these branches, the Committee, therefore, suggests that they should be grouped in one department to be known as "The Department of Pure and Applied Chemistry."

The Department, as a whole, should be placed under a Professor with whom should be associated at least four Assistant Professors responsible for selected branches of the subject. "The Committee further recommends after full considerations that this Professor should be an organic chemist, whose duties "would be to take charge of the Department as a whole, to conduct and guide research work in his subject, particularly with a view to affording help to industry, and to foster contacts with the existing and future industries of the country. If these tasks are thoroughly undertaken, the Professor will require adequate assistance and we suggest that Dr. P. C. Guha would be a suitable Assistant Professor of Organic Chemistry." We, however, doubt very much whether such a super-professor possessed of a cranial cavity containing four different brain-matters can at all be found ; we are further afraid that an organic chemist cannot properly manage and direct other branches of chemistry. It were much better if the sub-departments in chemistry were separated, each under its own head, as is the practice now.

The salary of the Professor is recommended to be Rs 1,500-50-2,000, as it is unlikely that a man of eminence will be obtainable at a lesser salary. The recommendation is also made for the creation of three assistant professorships, one in each of the departments of Physical Chemistry, Inorganic and Mineral Chemistry, and Pharmacological and Medicinal Chemistry, on a salary of Rs 600-40-800, but it is hoped that the creation of a full professorship in Physical Chemistry will not be long delayed. The establishment of the last named post was recommended by the Sewell Committee and sanctioned by the Council, but no steps have so far been taken to implement this sanction.

The Department of Electrical Technology has suffered a good deal in the last few years due to the constant changes and alterations in the staff. There can be little continuity in the work of a department whose staff undergoes constant change. The Central Workshop should be, in the opinion of the Committee, placed under the direct control of the head of the Department of Electrical Technology, because of all the departments this one is most intimately connected with workshop practice and also because the workshop will be more efficiently conducted under the supervision of an engineer than under a professor of pure science. We are of opinion that the centralization of the workshop was an unnecessary and uncalled-for step and was mainly responsible for the resignations of Profs. Watson and Mowdawallah. It were much better if the Irvine Committee restored the previous condition, *i.e.*, separate workshops for Departments of Electrical Technology, Physics, and Physical Chemistry. The present measure will lead to friction.

To ensure stability of services and avoid constant staff changes, the Committee recommends :—

> "In place of Professorships and Assistant Professorships being tenable for five years with the prospect of renewal, these appointments if confirmed, should continue until an age limit to be fixed by the Council is reached, with the usual safeguard regarding termination of the appointment."

A good deal of trouble in the Institute is due to insecurity of service of all other employees except of the Director who has got a secure tenure of 15 years. The above recommendation is to be welcomed as a step in the right direction.

Conclusion

Such are in short the main recommendations of the Irvine Committee. The hopes raised in us when the Committee was appointed in January last year have been very largely fulfilled, and we are glad that Sir James Irvine's Committee have agreed in general with our views as pointed out in the editorial article already referred to. But whatever be the nature of the recommendations, they can seldom be effectively enforced unless there is a spirit of harmony and co-operation which, the Committee makes it clear in unmistakable terms, does not exist at present in the Institute. We have no doubt that a better atmosphere can be created with the administrative changes now introduced and when the security of position of the staff of the Institute is ensured. It is a matter of pleasure to us that almost all the recommendations made by the Committee have been accepted by the Council and the Government. We can do no better than quote the following from the report in closing the discussion :

> "It may be the case that our proposals are a compromise, forced upon us by circumstances, but nevertheless we believe that they represent a workable solution of existing difficulties. If given a fair trial and if operated in the right spirit, they will enable the Institute to begin its second semi-Jubilee period with renewed hope. If our scheme fails, it can only be through the clash of personalities beyond the remedy of any powers possessed by a Reviewing Committee."

Psychological Factors

C. G. Jung
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THE separation of psychology from the premises of biology is purely artificial, because the human psyche lives in indissoluble union with the body. And since these biological premises hold good not only for man but for the whole world of living beings the scientific basis on which they rest obtains a validity far exceeding that underlying a psychological-judgment, which is valid only in the realm of consciousness. Therefore it is not a matter of surprise that the psychologist is often prone to reach back to the security of the biological viewpoint, and to borrow freely from physiology and the theory of instinct. Nor is it astonishing to find a widely accepted point of view, which regards psychology as merely a chapter in physiology. Although psychology rightly claims autonomy in its own special field of research, it is true that it must recognize a far-reaching correspondence between its facts and the data of biology.

Among the psychic factors determining human behaviour, the instincts are primarily the motivating forces of psychic events. In view of the controversy which has raged around the nature of the instincts, I would like to establish clearly what seems to me to be the relation between the instincts and the psyche and why I name instincts as psychological factors. If we started with the hypothesis that the psyche is absolutely identical with the state of being alive, then we would have to accept the existence of a psychic function even in unicellular forms. In that case, instinct would form a type of psychic organ and the hormone-producing glandular activity would have a psychic causality.

But if we look upon the appearance of the psyche as a relatively recent event in evolutionary history, and assume that the psychic function is a phenomenon accompanying a nervous system, which in some way or other has become centralized, then it would be difficult to believe that the instincts were originally psychic in nature. And since the connexion of the psyche with the brain is a more probable conjecture than the psychic nature of life in general, I regard the characteristic compulsoriness of the instincts as an ecto-psychic factor. None the less, it is psychically important, because it leads to the formation of structures or patterns, which may be regarded as determinants of human behaviour. Under these circumstances, the immediate, determining factor is not the ecto-psychic instinct, but that structure which results from the interaction of the instinct and the psychic situation of the moment. Thus the determining factor would be a modified instinct. The change undergone by the instinct is as significant as the differences between the colour we see and the objective wave-lengths producing it. The ecto-psychic fact of instinct would play the role of a stimulus merely, while the psychic instinct-phenomenon would be an assimilation of this stimulus to a pre-existing psychic complexus. A name is needed for this process. I would term it psychification. Thus, what we call instinct offhand would be a datum already psychified, but of ecto-psychic origin.

General Phenomenology

The concept outlined above makes it possible to understand the variability of the instinctive factors within the general phenomenology. The psychified instinct forfeits its uniqueness to a certain extent, at times actually losing its most essential characteristic—compulsoriness; it is no longer an ecto-psychic, unequivocal fact, but has become instead a modification conditioned by its encounter with a psychic datum. As a determining factor, instinct is variable and therefore lends itself to different applications. Whatever the nature of the psyche may be, it is endowed with an extraordinary capacity for variation and transmutation.

For example, no matter how unequivocal the physical state of irritation called hunger may be, the psychic consequences resulting from it can be manifold. Not only can the reactions to ordinary hunger vary widely, but the hunger itself can appear as denatured, or even as metaphorical. It is not only that we use the word hunger in the most varied sense, but by combination with other factors, the hunger itself can assume the most varied forms. The originally simple and unequivocal determinant can appear transformed into pure greed, or into many aspects of boundless desire of insatiability, as for example, the lust for gain or inordinate ambition.

Hunger, as the characteristic expression of the urge to self-preservation, is without doubt one of the primary and most powerful factors influencing behaviour; in fact, the lives of primitives are more affected by it, and more powerfully, than by sexuality. At this level of existence, hunger means the alpha and omega—existence itself.

The importance of the instinct of preservation of the species is obvious. However, the growth of culture having brought with it so many restrictions of a moral and a social nature, sexuality has been lent, temporarily at least, an excess value comparable to that of water in a desert. Because of the premium of intense sensuous enjoyment which nature has set upon the business of reproduction, the urge towards sexual satisfaction appears in man—no longer conditioned by a mating season—as an almost separate instinct. The sexual instinct enters into combination with many feelings and aspects, with spiritual and material interest, and to such a degree, that, as is well known, the attempt has even been made to trace the whole of culture to these combinations.

Sexuality, like hunger, undergoes a radical psychification, which makes it possible for the primarily purely instinctive energy to be diverted from its biological applications and turned into other channels. The fact that the energy can be deployed into various fields indicates the existence of still other drives strong enough to change the direction of the sexual instinct and to deflect it, at least in part, from its immediate goal.

I would like, then, to differentiate as a third group of instincts the *drive to activity.* This urge functions when the other urges are satisfied—indeed, it is perhaps only called into being after this has occurred. Under the concept of activity would fall *Wanderlust*, love of change, restlessness, and the play-instinct.

There is another drive, different from the instinct for activity and, as far as we know, specifically human, such might be called the reflection-urge. Ordinarily we do not think of "reflection" as ever having been instinctive, but associate it with a conscious state of mind. *Reflexio* means bending back and, used psychologically, would express the fact that the reflex process which conducts the stimulus over into the instinctive discharge is interrupted by psychification. Owing to the interference of reflection taken in this automatic sense, the psychic processes exert an attraction on the impulse-to-action excited by the stimulus. Therefore, before having discharged itself in the external world, the impulse is deflected into an endo-psychic activity. Reflexio is a turning inward with the result that instead of an immediate *act*, various derived contents or conditions result, which may be termed reflection or deliberation. Thus, in place of the compulsive act, there appears a certain amount of freedom, and in place of the predictability a relative unpredictability as to the effect of the impulse.

The richness of the human psyche and its essential character are probably determined by this reflection-urge. Reflection re-enacts the process of excitation and conducts its stimulus over into a series of images, which, if the impetus is strong enough, is finally reproduced in some form of expression. This may take place directly, for instance in speech, or may appear in the form of abstract thought, of impersonations, of ethical conduct, or again, it may be expressed in a scientific achievement, or in a work of art, etc.

Through the reflection-urge, this stimulus is more or less wholly transformed into psychic content, that is, it becomes an experience: a natural process is transformed into a conscious content. Reflection is the cultural instinct *par excellence*, and its strength is shown in the power of culture to maintain itself in the face of untamed nature.

Instincts are not creative in themselves, because they have been stably organized and have therefore become automatic. The reflection-urge is no exception to this rule, for the production of consciousness is not of itself a creative act, but may under certain conditions be a merely automatic process. It is a fact of great importance that this compulsion, so feared by civilized man, also produces that characteristic fear of becoming conscious, best observed in neurotic persons, but not in them alone.

Although in general instinct is a system of definitely organized tracks and consequently tends towards unlimited repetition, yet man has the distinctive power of creating something new in the real sense of the word, just as nature, in the course of long periods of time, succeeds in creating new forms. Though we cannot classify it with a high degree of accuracy, the creative instinct demands special mention. I do not know if "instinct" is the correct word. We use the term creative instinct, because this factor behaves at least dynamically, like an instinct. Like instinct it is compulsive, but it is not common, and it is not a fixed and invariably inherited organization. Therefore I prefer to designate the creative impulse as a psychic factor similar in nature to instincts, having indeed a very close relationship to the instincts, but without being identical with any one of them. Its connexions with sexuality are a much discussed problem, and, furthermore, it has much in common with the activity-urge as well as with the reflection-urge. Still it can repress all of these instincts, or make them serve it to the point of the self-destruction of the individual. Creation is as much destruction as construction.

To recapitulate, I emphasize the fact that from the psychological standpoint, five main groups of instinctive factors can be differentiated : hunger, sexuality, activity, reflection, and the creative. And in the last analysis, instincts are ecto-psychic determinants.

A discussion of the dynamic factors determining human behaviour is obviously incomplete without mention of the will. The part that will plays, however, is a matter of dispute, and the whole problem is bound up with philosophical considerations, which in turn are burdened with the premises of a *Weltanschauung*. If the will is posited as free, then it is not bound to causation and there is nothing more to be said about it. If it is to be taken as pre-determined and placed in a relationship of dependence upon the instincts, then it is an epiphenomenal factor of secondary importance. The same applies to the effects and therefore I cannot more than mention them here.

Different from the dynamic factors are the modalities of the psychic function, which influence human behaviour in other respects. Among these I mention especially the sex, age, and hereditary disposition of the individual. These three factors are taken first as physiological facts, but they are also psychological factors inasmuch as, like the instincts, they are subjected to psychification. Anatomical masculinity, for instance, is far from being proof of the psychic masculinity of the individual. And similarly, physiological age does not always correspond with the psychological. As regards hereditary disposition, the determining factor of race or family can be suppressed by a psychological superstructure. Much which is interpreted as heredity in the narrow sense is rather a sort of psychic contagion, which consists in an adaptation of the child-psyche to the unconscious of the parents.

To these three semi-physiological modalities, I should like to add three that are psychological. Among these I wish to stress the conscious and the unconscious. It makes a great deal of difference in the behaviour of the individual, whether the psyche is functioning mainly consciously or unconsciously. Naturally it is only a question of a greater or lesser degree of consciousness, because total consciousness is empirically impossible. An extreme state of unconsciousness is characterized by the predominance of compulsive instinctive processes, the result of which is either uncontrolled inhibition, or a lack of inhibition throughout. The happenings within the psyche are then contradictory and take place in terms of alternating, a-logical antitheses. In such a case, the level of consciousness is essentially that of the dream-state. In contrast to this, a high degree of consciousness is characterized by a heightened awareness, a preponderance of will, a directed rational behaviour, and an almost total absence of instinctive determinants. The unconscious is then found to be at a level definitely animal. The first state lacks intellectual and ethical accomplishment, the second naturalness.

The second modality is extraversion and introversion, and determines the direction of psychic activity, that is, it decides the question whether conscious contents refer to external objects or to the subject. Therefore, it also decides the question whether the value stressed lies without or within the individual. This modality works so persistently that it builds up habitual attitudes, that is, types with recognizable external traits.

The third modality points, to use a metaphor, upward and downward, because it has to do with spirit and matter. It is true that matter is in general the subject of physics, but it is also a psychic quality, as the history of religion and philosophy clearly shows. And just as matter is finally to be conceived of as being merely a working hypothesis of physics, so also spirit, the subject of religion and philosophy, is a hypothetical quality in constant need of re-interpretation. The so-called reality of matter is attested in the first place by our sense-perceptions, while belief in the existence of the spirit is supported by psychic experience. Psychologically, we cannot establish anything more final with respect to either matter or spirit than the presence of certain conscious contents, some of which are to be labelled as having a material and others a spiritual origin. In the consciousness of civilized peoples, it is true, there seems to exist a sharp division between the two qualities, but on the primitive level, the boundaries become so blurred that matter often seems endowed with soul while spirit appears to be material. However, from the existence of these two categories, ethical, aesthetic, intellectual, social, and religious systems of values eventuate, which on occasion determine how the dynamic factors in the psyche are to be finally used. Perhaps it would not be too much to say that the most crucial problems of the individual and of society turn upon the way the psyche functions towards spirit and matter.

Special Phenomenology

Let us now turn to the special phenomenology. In the first part we have differentiated five principal groups of instincts and six modalities. However, the concepts described are only academically valuable as general categories. In reality, the psyche is a complicated interplay of all these factors. Moreover, in conformity with its peculiar structure, it shows an endless individual variability on the one hand and on the other an equally great capacity to undergo change and differentiation. The variability is conditioned by the circumstance that the psyche is not a homogeneous structure, but apparently consists of hereditary units only loosely bound together, and for this reason it shows a very marked tendency to split into parts. The tendency to change is conditioned by influences coming both from within and from without. Functionally speaking, both tendencies are closely related to each other.

(1) Let us first turn to the question of the psyche's tendency to split. Although this peculiarity is most clearly observable in psychopathology, yet fundamentally it is a normal phenomenon, which can be recognized with greatest ease in the projections made by the primitive psyche. The tendency to split means that parts of the psyche detach themselves from consciousness to such an extent that they not only appear foreign but also lead an autonomous life of their own. It need not be a question of hysterical multiple personality, or schizophrenic alterations in personality, but merely so-called complexes quite in the field of the normal. Complexes are psychic fragments, which owe their splitting off to traumatic influences or to certain incompatible tendencies. As the association experiment proves, the complexes interfere with the purposes of the will and disturb the performances of consciousness; they produce disturbances in memory and obstacles in the flow of associations; they appear and disappear according to their own laws; they obsess consciousness temporarily, or influence speech and action in an unconscious manner. In a word complexes behave like indepen-

dent beings, a fact especially evident in abnormal states of mind. In the voices heard by the insane, they even take on a personal ego-character like that of the spirits manifesting themselves through automatic writing and similar techniques. An intensification of the complex-phenomenon leads to morbid states which are only more or less extensive multiple dissociations endowed with an invincible life of their own.

The behaviour of new contents, which have been constellated in the unconscious, but are not yet assimilated to consciousness, is similar to that of the complexes. These contents can be based on subliminal perception, or they may be creative in character. Again, so long as they are not made conscious and integrated with the life of the personality, they also lead a life of their own. In the realm of artistic and religious phenomena, these contents likewise appear at times in personified form, especially as so-called archetypal figures. Mythological research designates them as "motives"; to Levy-Bruhl they appear as *representations collectives*; Hubert and Mauss call them "categories of fantasy." I have employed the concept of the collective unconscious to embrace all of these archetypes. They are psychic forms which, like the instincts, are common to all mankind, and therefore their presences can be proved wherever relevant literary documents have been preserved. As factors influencing human behaviour, the archetypes play no small role. The total personality can be affected by them through a process of identification. This effect is best explained by the fact that the archetypes probably represent typical situation of life. Abundant proof of such identifications with archetypes is furnished by psychological and psychopathological cases. The psychology of Nietzsche's Zarathustra also furnishes a good example. The difference between these structures and the split-off products of schizophrenia lies in the fact that the former are entities endowed with personality and fraught with meaning, whereas the latter are only fragments with vestiges of meaning—in reality they are products of disintegration. Both however possess to a high degree the capacity of influencing, controlling, or even suppressing the ego-personality, so that a temporary or lasting transformation of personality occurs.

(2) As we have seen, the inherent tendency of the psyche to split means on the one hand dissociation into multiple structural units, on the other, however, a possibility very favourable to change and differentiation: it allows the singling out of special parts in order to train them through concentration of the will and thus bring them to their maximum development. In this way, with a conscious onesidedness, certain capabilities, especially those promising social usefulness, can be fostered to the neglect of others. This produces an unbalanced state similar to that caused by a dominant complex—a change in personality. It is true that we do not refer to this as obsession by a complex, but as onesidedness. Still, the actual state is approximately the same, with this difference that the onesidedness lies within the intention of the individual, and is therefore furthered by all possible means, whereas the complex is felt to be injurious and disturbing. Frequently one fails to see that the consciously-willed onesidedness is one of the most important causes of an undesirable complex, or conversely, that certain complexes cause a onesided differentiation of doubtful value. Some degree of onesidedness is unavoidable and, in the same measure, complexes are also unavoidable. Looked at in this light, complexes might be identified with certain modified instincts. An instinct, which has undergone too much psychification, can revenge itself in the form of an autonomous complex. This is the chief source of the neuroses.

It is well known that very many faculties can become differentiated in man. I do not wish to lose myself in the details of case-histories and therefore limit myself to the normal and ever-present faculties of consciousness. Consciousness is primarily an organ of orientation in a world of outer and inner facts. First and foremost, consciousness establishes the fact that something is there. I call this faculty *sensation.* By this I do not mean any specific sense activity, but perception in general. Another faculty gives the interpretation of that which is perceived. This I term *thinking.* By means of this function, the thing perceived is assimilated and the transmutation of the object of perception into a psychic content proceeds much further than in mere sensation. A third faculty establishes the *value* of the object. This function of evolution I call *feeling*. The pain or pleasure reaction of feeling marks the highest degree of subjectification of the object. Feeling brings subject and object into such close relationship that the subject must choose between acceptance and rejection.

These three functions would be quite sufficient for orientation with respect to any fact, if the object in question were isolated in time and space. But, in space, every object is in endless connection with the multiplicity of objects, and, in time, the object represents merely a transition from a former condition to the succeeding one. The greater part of spatial relationship and temporal change is unavoidably unconscious at the moment of orientation, and yet, for the determination of the meaning of an object, space-time relationships are necessary. It is the fourth faculty of consciousness, namely, *intuition*, which makes possible, at least approximately, the determination of the space-time relationship. This is a function of perception, which includes the subliminal, that is, the possible relationship of objects not appearing in the field of vision, and the possible changes in past and future, about which the object itself gives no clue. Intuition is an immediate awareness of relationships, which could not be established by the other three functions at the moment of orientation.

I mention the orientating functions of consciousness, because they can be singled out for empirical observation and are subject to differentiation. At the very outset, nature has established marked differences in their importance for different individuals. As a rule, one of the four functions is especially developed, which consequently gives the mentality as a whole its characteristic stamp. Through the predominance of one function, there result typical dispositions, which can be designated as thinking types, feeling types, etc., as the case may be. Such a type-form is a bias like a vocation, with which a person has identified himself. Whatever has been erected into a principle or a virtue through inclination or usefulness always results in onesidedness and a compulsion towards onesidedness, which excludes all other possibilities, and this applies to men of will and action just as much as to those whose object in life is the constant training of memory. Whatever we persist in excluding from conscious training and adaptation necessarily remains in an untrained, undeveloped, infantile, or archaic state, ranging from partial to complete unconsciousness. Hence, together with the motives of consciousness and reason, unconscious influences of a primitive character are always normally present in ample measure and disturb the attention of consciousness. For it is by no means to be assumed that all those forms of activity latent in the psyche which are suppressed or neglected by the individual are thereby robbed of their specific energy. For instance, if a man relied wholly on the data of vision, this would not mean that he would cease to hear. And if he could be transplanted to a soundless world, he would in all probability soon satisfy his desire of hearing by indulging in auditory hallucinations.

The fact that the natural function of the psyche cannot be stripped of their specific energy gives rise to characteristic antitheses, which can be best observed in the field of activity where these four orientating functions of consciousness come into play. The chief contrasts are those between thinking and feeling on the one hand, and between sensation and intuition on the other. The opposition between the first two is an old story and needs no comment. The opposition between the second pair becomes clear when understood as the opposition between the objective fact and the apparent possibility. Obviously anyone on the lookout for new possibilities does not rest in the actuality of the moment, but passes on beyond it as soon as possible. These contrasts are marked by their irritating nature and this is equally true when the conflict occurs within the individual psyche or between individuals of opposite temperaments.

It is my belief that the problem of the opposites, here merely hinted at, should be made the basis of a critical psychology. A critique of this sort would be of utmost importance not only for the narrow field of psychology, but also for the wider field of the cultural sciences in general.

In this paper, I have gathered together all those factors which, from the standpoint of a purely empirical psychology, play a leading role in determining human behaviour. The multiplicity and variety of the aspects claiming attention are due to the nature of the psyche—the mirroring of itself in manysided facets—and they are a measure of the difficulties confronting the investigator. The tremendous intricacy of psychic phenomenology is borne in upon us only after we see that all attempts to formulate a comprehensive theory are foredoomed to failure. The premises are always far too simple. The psyche is the starting-point of all human experience, and all knowledge gained eventually leads back to it. The psyche is the beginning and the end of every realization. It is not only the object of its science, but the subject also. This lends psychology a unique place among all the other sciences: on the one hand there is a constant doubt as to the possibility of its being a science at all, while on the other, psychology gains the right to state a theoretical problem, the solution of which will be one of the most difficult tasks of a future philosophy.

In my survey far too condensed, I fear I have left unmentioned many illustrious names. Yet there is one which I would not like to omit. It is that of William James, whose psychological vision and pragmatic philosophy have more than once been my guides. It was his comprehensive mind which made me realize that the horizons of human psychology widen into the immeasurable.*

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* Printed with the kind permission of the Director of the Harvard Tercentenary Conference.

The Education of the Deaf in India

In *The Volta Review* Jatindra Mohan Datta has given an analysis of the education provided for the deaf in India. The numbers of deaf-mutes during the last four censuses were: 1901—153,163; 1911—199,891; 1921—189,644; 1931—230,895. For the same years, the numbers of deaf-mutes per 100,000 population were: 1901—52; 1911—64; 1921—60; 1931—66. A comparison of the figures shows that the proportion of the deaf-mutes is on the increase. The number of deaf children of the school-going age is 86, 840, of which only 1,000 actually attend school. Bengal can boast of 6 such schools—the largest for a single province—with a total number of 268 pupils, though the 7th school has since been started. Similar figures for Madras are 4 and 258 respectively; for Bombay 4 and 157, for Burma 1 and 27, for C. P. 1 and 20. The United Provinces, the Punjab, and Bihar & Orissa have so for no such schools, though a move has recently been made to establish one at Cawnpore, the first in the province. Among the Native States Baroda and Mysore have 2 institutions each for the deaf with 90 and 100 pupils respectively.

Thus the total number of institutions in this country is 20 attended by 914 scholars, the percentage being only .57, Bombay has, to her credit, the highest percentage of deaf-mutes receiving instruction, and Bengal is a low second—the figures being 2·6 and 1·4 repectively. The incidence of the disease, in India as in every other country, is greater among males than among females.

Turbulence

M. P. Srivastava

General

THE study of turbulence dates back to the year 1843 when Prof. Stokes pointed out that the change from the steady to the eddying state was due to steady motion becoming unstable. A systematic study, however, was taken up by Osborne Reynolds in the year 1883 with the distinction that he ascribed turbulence to viscosity instead of instability. He demonstrated it by a series of experiments on the flow of water in glass tubes of various diameters up to 2″. Reynolds came to the following conclusions:—

That turbulence occurred when (*a*) the transverse variations of velocity exceeded a certain limit and (*b*) the fluid was bounded by solid bodies. From geometric similarity of flow of two liquids Reynolds found that the ratio of the inertia forces to frictional forces must be the same for the two liquids, *i.e.*, vl/ν is a constant where v is the velocity, l the linear dimension of the body or bodies which bound the fluid in any way, and ν the coefficient of kinematic viscosity. In the atmosphere l may be considered to be the height of the troposphere or better the height of the homogeneous atmosphere. The motion in the atmosphere is turbulent for a lesser value of the Reynolds number, as the coefficient of viscosity of air is low. The Reynolds number cannot, however, be used as a criterion for determining turbulent motion in the atmosphere as Reynolds' analysis supposes that in the different states of flow the only differences are those of the size of the boundary and the rate of flow, the nature of the fluid remaining unchanged. In the atmosphere, however, there is a further complication due to the existence of a lapse-rate of temperature, a large lapse-rate helps the formation of turbulence whereas an inversion checks it.

The real advance in this direction was made by Akerblom, who showed that the Euler-Navier equations could be used to interpret correctly atmospheric movements if for the molecular viscosity another suitable coefficient characterizing the apparent or vertical atmospheric viscosity was substituted. Later on Hesselberg and Sverdrup with the abundant aerological material of Lindenberg made further devolopments in the ideas of Akerblom and found that the coefficient of virtual viscosity increases from a very small value close to the surface to many times at about 300 metres and remains constant above that height. All the work of Akerblom, Hesselberg, and Sverdrup did not say why the coefficient of virtual friction varies in space and time. Although Hesselberg and Sverdrup recognized that the virtual friction was due to turbulence, they failed to show how turbulence could produce such an effect. It was left for G. I. Taylor to accomplish this. He started from the idea that there is always an exchange of mass between different horizontal layers, the small eddies leaving their mother layers and travelling upwards or downwards till they are assimilated by the surroundings, the exchange of mass is accompanied by exchange of properties characteristic of the different air layers, *viz.*, water vapour, heat and momentum. Simultaneously with G. I. Taylor or a little later W. Schmidt published a paper on a similar subject and came to the same conclusion as Taylor. He discussed the diurnal variation of temperature in the free atmosphere, the influence of large cities on climate and showed the wide applicability of these mathematical results to different problems. Schmidt used the term *Austausch* (exchange) $A = k\rho$ which is almost the same as Taylors "Eddy conductivity', the former being generally used by German writers. L. F. Richardson later took up the work of Taylor and Schmidt and computed by different methods a number of values of eddy conductivity and eddy viscosity. Richardson came to a general conclusion that the eddy conductivity is very small, close to the surface, then increases to a maximum within the first kilometer and finally at higher levels it again decreases. Richardson was the first to take up the general problem of finding the physical factors which create turbulence.

Taylor in his treatment of diffusion of heat by turbulence did not take account of the dry adiabatic lapse rate which was later done by Brunt. Prandtl made an attempt to express the eddy stresses in terms of the velocity of the mean motion. He introduced a length characteristic of the state of turbulence which is similar to the mean free path in the kinetic theory of gases or in other words is regarded as a diameter of a mass of fluid moving as a whole and also as the length of the path described by such a mass of fluid before it loses its individuality by mixing with neighbouring masses; he regarded mixing as a discontinuous process. As it is far from the truth, mixing being a continuous process—Taylor gave a theory which seems very promising and along which good progress can be made in the study of turbulence.

What is Turbulence?

Turbulence is in general an irregular flow which manifests itself in fluids, gaseous or liquid, when they flow past solid surfaces or even when neighbouring streams of the same fluid flow past or over one another. The actual motion is so irregular that very little is known of its details. It is equally very difficult to say how or why turbulence arises, all that one knows is a little about the conditions which are to be fulfilled for the motion to be a stream-line one, *i.e.*, the path of the particle everywhere coincides with the mean velocity of the particle at that point. In the atmosphere turbulence becomes visible through the trail of smoke of a chimney or gusts and lulls in the trace of an anemometer.

Turbulence in liquids. Osborne Reynolds was the first to study in thorough detail the transition from laminar flow to turbulent flow in liquids. The velocity at which eddy formation is first noticed in such experiments is called the 'higher critical velocity.' There is a 'lower critical velocity' at which the eddies in originally turbulent flow die out. It is customary to distinguish between two types of flow, the first in which the flow is perfectly regular and Poiseuille's law is obeyed is generally called the laminar or stream-line flow and the second the turbulent flow which is characterized by the presence of wandering vortices or eddies, the velocity not being in one direction but varying with time and position in an irregular manner. The explanation of the difference between stream-line and turbulent motions was given by Osborne Reynolds who showed that viscosity has the effect of tending to prevent turbulence from being formed. It is for instance possible to run glycerine or oil very much faster than water through a pipe without breaking down the stream-line motion. The larger the pipe the lower is the speed of flow at which turbulence sets in.

Turbulence in the atmosphere. The flow of the atmosphere over the earth's surface, which may be compared with that of air in a very large pipe, might be expected to become turbulent at a very low speed. Although velocity seems to have no moderating influence on turbulence in the atmosphere, the effect of density seems to be very marked. On a clear night when the air near the ground is cold, and hence heavy, turbulence is prevented because the wind has not sufficient energy to raise the heavy air from the ground and replace it by lighter air from above.

How is turbulence produced in the atmosphere? Eddies very near the earth's surface are formed by various obstructions to the wind movement such as buildings, trees, etc., and by variations in topography; but these eddies are sensibly stationary so that in a steady wind any light material such as dust, chaff, or snow which may be carried along in the air movement is seen always to follow the same trajectory or path of motion in passing any particular one of these obstructions. It frequently happens that when two oppositely moving currents approach each other, the velocity gradients reach a certain critical value for these layers of fluid and the stresses developed within them reach the point where the stability is no longer possible for laminar flow and possibly through some local variations in flow a disturbance will suddenly be set up near the boundary between the two. What usually occurs in practically every instance where eddies are formed at the boundary of separation between the two air currents is that the eddies are carried along by one or the other, depending on the fact as to which of the two currents is stronger.

The Nature of Eddies

It is very difficult to give a clear-cut defination of an eddy. The eddies which generally form at the edge of a stream flowing into a millpond are of the nature of vortices with vertical axes but when we come to dealing with the atmosphere then the word eddy is no longer restricted to vortices. It can only be defined as a physical entity which disturbs the uniform flow of the air and includes rotating eddies, convection currents, and any other type of disturbances.

Formation of Eddies

If we have two streams of fluid of different origin flowing at the back of a sharp corner, the Bernoulli *constant* of the two streams will be different and as the pressure along the surface of discontinuity is the same the velocities in the two streams would be different. In this case there is a longitudinal discontinuity in the velocity. If the flow of the two streams be in different directions with the same Bernoulli constant then there is a transverse discontinuity in the velocity. These surfaces of discontinuity, being unstable, do not last long. There is a tendency for the velocity to increase at some place and diminish at another. The result of this is that the surface of discontinuity breaks up into a large number of eddies or vortices. Rosenhead, as a result of his investigation of the flow of a stream of density ϱ and velocity u in the direction of the axis of x above a stream of the same density but flowing in the opposite direction, came to the conclusion that the effect of instability on a surface of discontinuity of sine-form is to produce concentrations of vorticity at equal intervals along the surface, the surface of discontinuity tending to roll up round these points of concentration. Eddies may also be formed by the flow of a fluid past a sharp edge. The velocity at the edge is large and theoretically should be very large, but observations show that the velocity diminishes due to the formation of eddies. What happens is that probably there is an eddy behind the sharp edge which causes the fluid to approach the edge from behind; thus we have two fluids flowing at the edge. A surface of discontinuity is formed there and is rolled up by the eddy which, being fed afresh, grows on. As a matter of fact the eddy and the surface of discontinuity form one entity and grow simultaneously. Later on the eddy detaches itself and the surface of discontinuity which is being renewed at the edge breaks up into separate eddies.

Rate of Decay of Eddies

The manner in which eddies die out is not at all understood. There seem to be two main causes:—(*a*) the action of viscosity between rings of fluid rotating with different angular velocities; (*b*) forces due to dynamical causes which tend to reduce the tangential velocity of the fluid in the eddy. In the case of large eddies the cause (*b*) depending on the square of the velocity will be more important whereas in the case of slowly rotating eddies the motion will be determined by viscosity, the effect of which is proportional to the velocity. It is, however, very difficult to apply these ideas to the atmosphere as there are no circular eddies present in the atmosphere. From the works of Taylor, Hesselberg, Sverdrup, Brunt, and others we know a little about how the wind varies with height and the rate at which momentum is transferred from one atmospheric layer to another, but the general problem of turbulent motion in the atmosphere is still far from being understood.

The Partition of Eddy Energy

Taylor investigated the relationship between the variations of wind velocity along and across the mean direction of the wind. He selected the records where the wind appeared to keep a steady mean direction and speed over a period comprising a large number of gusts or eddies. He drew two dotted lines on each trace to include all but a few extreme gusts and measured two extremes of wind direction and two of wind velocity. If V_{max}

and V_{min} be the maximum and minimum velocities and the angular variation of wind velocity be θ, then by plotting $\frac{V_{max} - V_{min}}{V_{max} + V_{min}}$ against $\sin\frac{\theta}{2}$ a straight line is obtained. This conclusively shows that the horizontal component of eddy motion across the wind is equal to the component along the direction of the mean wind, *i. e.*, if u', v', w' be the components of eddy velocity about the mean value $\bar{u}$ ($\bar{v} = \bar{w} = 0$), then $\bar{u}^2 = \bar{v}^2$. To compare the values of v' and w', Taylor used tethered balloons and found that $\bar{v}^2 = \bar{w}^2$, thus establishing a complete equipartition of eddying energy.

Scrase repeated the observations of Taylor by the help of a bi-directional vane and found that v' and w' components are not equal. At 2 metres the ratio of the v' component to w' component is 1.59 and and at 18 metres it is 1.20. On an average Scrase finds that the ratio of the lateral diameter to the vertical diameter is 1.5 or in other words is more than twice as great as $\bar{w}^2$

Vertical Transfer of Heat by Turbulence

The rate at which heat is carried upward or downward by eddies has been given by G. I. Taylor, who found that the upward flow of heat due to eddies could be given by $-K\varrho C_p \frac{\delta\theta}{\delta Z}$ where ϱ is the density, C_p the specific heat of air at constant pressure, θ the potential temperature at height Z and K an essentially positive quantity which measures the activity of the eddy at height Z. This treatment of Taylor suffers from a disadvantage as it applies only to an incompressible atmosphere. The corresponding analysis for compressible fluid has been given by Brunt who expresses the flux of heat by turbulence in terms of the absolute temperature T and not in terms of potential temperature as done by Taylor. Taylor did not take account of radiation in his treatment which has been done by Brunt. For the resultant upward eddy flow of heat across the isobar p, Brunt gets the expression $-K\varrho C_p \left(\frac{\delta T}{\delta Z} + \Gamma\right)$ where $K = \frac{\Sigma m(p_0 - p)}{g\varrho^2}$, m being the mass of the eddy, p_0 the standard pressure (1000 mv), p the pressure and ϱ the density. The corresponding expression derived by Taylor is

$$-K\varrho C_p \frac{\delta\theta}{\delta Z}$$

K being defined by $\overline{w\,(Z_0 - Z)}$ where w is the vertical velocity and Z the vertical co-ordinate of an eddy which originated at Z_0. This difference between Taylor's and Brunt's treatments is that Taylor assumed the flow of heat to be proportional to the potential temperature while Brunt considered it to be proportional to the absolute temperature. In Taylor's treatment as in that of Brunt the moving eddy is supposed to take up the pressure of its surroundings or, in other words, the mixing takes place at constant pressure and in mixing with the surroundings the eddy shares its excess or defect of thermal energy. A further advantage of Brunt's treatment is that it enables us to decide how the flow of heat upwards or downwards depends on the lapse-rate. The factor $\left(\frac{\delta T}{\delta Z} + \Gamma\right)$ is the difference between actual lapse-rate and the dry adiabatic lapse-rate. The net eddy flow of heat is upwards, downwards, or zero according as the actual lapse-rate is greater than, less than, or equal to the dry adiabatic lapse-rate.

L. F. Richardson has, however, adopted a different treatment for the diffusion by eddies. Richardson's treatment, however, is not quite easy to understand.

The Combined Effects of Radiation and Turbulence

Brunt took account of the combined effect of radiation and turbulence in estimating the rate of change of temperature produced by eddies. He got the expression

$$\frac{\delta T}{\delta t} = (K_T + K_R)\frac{\delta^2 T}{\delta Z^2}$$

The variations of K_R (radiative diffusivity) are affected more by vapour pressure than by any other factor and consequently, K_R will not vary within wide limits with time of the day, as vapour pressure has no marked diurnal variation, K_T (Eddy-diffusivity) on the other hand is likely to vary within wide limits, as lapse-rate changes are smaller under stable than under unstable conditions in the vertical. This means that the temperature will increase with the height if $\frac{\delta^2 T}{\delta Z^2}$ is positive and fall if $\frac{\delta^2 T}{\delta Z^2}$ is negative, whether one considers effects of radiation or turbulence or both. There is, however, one point to be taken into consideration, *viz.*, that whereas the flow of heat by radiation is upwards or downwards according as the temperature decreases or increases with height that by turbulence is upwards or downwards according as the actual lapse-rate is greater or less than the dry adiabatic lapse-rate.

In deriving the eddying equation no account is taken of large-scale convection, since it is assumed that the area through which the flux of heat is measured and the time over which the conditions are averaged are both sufficiently great to include the effects of a large number of eddies. It does not, however, appear legitimate to assume that the time over which conditions must be averaged to yield a reasonable estimate of the effects of large-scale convection currents is sufficiently short so that it is permissible to neglect the changes in external conditions during this interval. Values of K vary within wide limits. K_R is comparable with K_T in inversions and is much smaller than K_T under conditions when there is vigorous turbulence.

Transfer of Momentum of Eddies

Schmidt starts from the assumption that an eddy preserves its momentum while moving from one layer to another and obtains an expression for the net gain of momentum by a unit volume of height Z

$$\frac{\delta}{\delta Z}\left(K\varrho\frac{\delta U}{\delta Z}\right)$$

He calls $K\varrho = A$ "Austausch (Exchange) Koeffizient'. This assumption of Schmidt is, however, not justifiable as the irregularities of motion in a turbulent fluid are associated with irregularities of distribution of static pressure and is possible that these pressure differences influence the horizontal momentum of the moving eddies. To avoid this objection, Taylor tackles the problem in another way. He considers two-dimensional motion and takes the vorticity to be constant—the vorticity of any element being unaffected by the local variations of pressure. The rate of loss of momentum by eddy transfer from a unit volume of the turbulent medium is given by

$$I = K\varrho\frac{\delta^2 U}{\delta Z^2}$$

In a recent paper Taylor tried to extend the vorticity-transport theory to three dimensions but without any success. His treatment is very lengthy. These lengthy results of Taylor reduce to two-dimensional flow parallel to the xz plane and to Prandtl's form when the motion is in the yz plane. The vorticity is no longer constant in three-dimensional flow as it is affected by the local variations of pressure. The momentum-transport theory developed by Schmidt, Prandtl, and others is applicable to three-dimensional motion, since u and v components of velocity are treated separately and independently. In the atmosphere the turbulent motion is in three dimensions and it becomes increasingly difficult to apply these results there. The cross-wind component v is greater than either of the other two components. Neither Taylor's results nor Prandtl's seem to represent the true conditions observed in the atmosphere. There is as a matter of fact no mathematical theory of turbulence in three dimensions which could be applied to the atmosphere. This is partly due to the complex nature af an eddy.

Prandtl's Theory of 'Mischungsweg'

In Prandtl's theory the essential step is the introduction of a parameter 'l' characteristic of the turbulence which is identical with the mean free path in the kinetic theory of gases. The length 'l' is regarded as a diameter of a mass of moving fluid and also as the path traversed by this mass relative to the rest of the fluid before it loses its individuality again by mixing with the turbulent fluid by which it is surrounded. It is not known if these lengths are exactly the same. Prandtl, however, adopts the second as a more convenient one and calls it 'Mischungsweg' or path of mixing. Prandtl considers two-dimensional motion. If u and v are the velocity components relative to the rectangular axes x and y, then

$$\varepsilon \text{ (Apparent Viscosity)} = l^2 \left| \frac{\delta \bar{u}}{\delta y} \right|$$

This is not quite accurate under certain conditions. Thus for flow in a channel when velocity is a maximum the above expression gives $\varepsilon = 0$ which is not the case. In order, therefore, to explain the discrepancy the statistical average over the section of breadth $2l$, *viz.* $\left\{\left(\frac{\delta \bar{u}}{\delta y}\right)^2\right\}^{\frac{1}{2}}$ should be considered.

Hence the correct expression for ε is

$$\varepsilon = l^2 \left\{\left(\frac{\delta \bar{u}}{\delta y}\right)^2 + l'^2\left(\frac{\delta^2 \bar{u}}{\delta y^2}\right)\right\}^{\frac{1}{2}}$$

It was pointed out by Prandtl that vorticity transport theory is incorrect for flow in a pipe. The reason for the failure of Taylor's theory is due to the fact that Taylor assumed the motion to be two-dimensional in the plane xz whereas it has been shown by Fage to be three-dimensional. The vorticity-transport theory fits better than the momentum-transport theory for flow in the wake of a long cylindrical body where there is a tendency to form vortices having axes parallel to the direction of the mean flow. In the boundary as shown by Prandtl, the vortices with their axes parallel to the mean flow will be independent of the local pressure differences and the flow of heat and momentum will be similar.

Prandtl's theory is based on the assumption that the pressure gradients on the fluid which accompany the eddying motion have no effect on the final result so that each particle continues to move with the horizontal momentum of the layer from which it originated till at last at some stage it mixes with the fluid at the level to which it penetrates. In Taylor's theory it is the vorticity which remains constant during the motion of the eddy, the momentum being modified in the journey by changes of pressure. Further, whereas the momentum-transport theory as developed by Prandtl and others is directly applicable to three dimensions, u and v components of velocity being treated separately and independently, the vorticity-transport theory does not apply to three dimensions as the moving eddy no longer retains its original component of vorticity being affected by local variations of pressure.

Limitations of 'Mischungsweg' Theory

The theory of Prandtl as developed by Von Karman is very useful and yields many interesting results and gives solutions of problems which had long remained unsolved. In spite of that it leaves unsettled certain important points, as for instance, the structure of turbulent motion and the connexion between the motion in central 'core' of the field and the boundary layers in the immediate vicinity of the walls. In the core the shearing stress is wholly determined by the turbulent motions and the fluid can be considered to be behaving as if it were an ideal fluid; in the boundary layers turbulence disappears and makes place for laminar viscous flow. But in some way the motions in these regions must influence one another. Moreover, the theory does not give any information about the balance of energy.

Applications of Turbulence in the Atmosphere

In the atmosphere where the motion is far from being laminar, turbulence plays an important part in the physics of the air. The variation of the wind velocity with height can be explained with some approximate truth on the assumption that K remains constant. K, however, does not remain constant. It is also difficult to say how K varies with height. If some law relating to the variation of K with height could be found that would be a very important contribution to meteorology and many important results could have been derived from it.

The diurnal variation of temperature falls with the value of K with increasing height, being $1/e$ of the surface value at 500 meters and $1/e^3$ of the surface value at 1500 meters. The observations do show that the diurnal variation of temperature falls till 500 meters but beyond this the agreement is not good, for the value of K is not reliable; besides, the effects of condensation of water vapour begin to be important at heights of about 1 km. and above.

Diffusion by Continuous Movements

Of late there has been a tendency to study diffusion by statistical methods. This was begun by Jacobson and continued in a remarkable way by Taylor and Richardson. This seems to be a much better way of handling the subject of turbulence. Taylor considers the state in which the turbulence in a fluid is uniformly distributed and the average conditions are the same everywhere. If u be the velocity parallel to the x axis and R_ξ the coefficient of correlation between the velocities of the particles at time t and $t + \xi$, then it has been shown by Taylor that $\sqrt{[X^2]} = \sqrt{[u^2]}T$ where X is the distance travelled by the particle in time t and T the interval of time sufficiently small such that R_ξ does not differ appreciably from unity. The above relation shows that the Standard Deviation of a particle from its initial position is proportional to T where T is small. In a turbulent fluid the most plausible assumption to be made is that R_ξ would fall to zero for large values of ξ. It might remain positive or become negative or oscillate before falling to zero but in either case there would be an interval of time T such that at the end of the interval there should be no correlation with the velocity at the beginning. In this case if $\lim_{t \to \infty} \int_0^t R_\xi \, d\xi$ is finite and equal to I, then $[X^2] = 2 [u^2] IT$, whence it follows that a continuous eddying motion may have the property that the S. D. of X is proportional to the square of the time. These theoretical results are confirmed by some of the experiments on the diffusion of smoke from a fixed point in a wind described by Richardson. He found that at small distances from the origin of the smoke the surface, containing the standard deviations of the smoke from a horizontal straight line to Leeward of the surface, is a cone.

At great distances Richardson's observations show that this surface becomes a paraboloid so that the deviation of the smoke is proportional to the square root of the time. Both these observations are in perfect agreement with Taylor's theory.

The ideas of Taylor have been developed by O. G. Sutton who considers mixing by turbulence taking place along the whole path of the eddy.

In the year 1929 Bürger applied the methods of statistical mechanics to the problem of turbulence in an entirely different way—the motion being considered two-dimensional. Bürger considers the main motion as broken up into the continually fluctuating relative motion and mean flow.

The various states of the relative motion are represented simultaneously by a number of points in space at a series of instants with equal intervals of time between them. He divides the space into a number of cells and considers the statistical probability of the total flow. His treatment, however, is difficult to follow. There is, however, no doubt that some advance has been made in the study of turbulence.

Recent Geological Changes in Northern India and their Effect upon the Drainage of the Indo-Gangetic Basin

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Introduction

THE earth has no claim to be called a *terra firma* as the earth's crust possesses no real stability. Under the weight of great mountains the crust bends and even gives way in cracks and fractures and folds. Even sudden great changes in barometric pressure, heavy tides, etc., produce tremors in the crust which are measurable by the seismographs, while there are some 10,000 perceptible earthquake shocks felt every year all over the globe. "As old as the hills" again is an expression which, though poetically acceptable, is scientifically inaccurate. The greatest and most imposing ranges of mountains like the Himalayas, the Alps, etc., are, geologically speaking, of only yesterday. They are very young compared with the sorely eroded, worn out ranges, such as the Aravallis, the remnants of a great chain which in past geological ages stretched across the length of India.

The surface features of the earth's crust, the distribution of sea and land, continents, mountains, rivers, lakes, are subject to constant and ceaseless change and every geological age comes to possess its own geographical features. This is the first and most important lesson of geology, Mountain-chains arise and are worn down to sea-level by the atmospheric agent; from their debris is built new land on the floor of the oceans, while the bottom of the sea is elevated to form new mountain-chains.

The changes that have taken place in India since the last geological age, the Pleistocene, have been of great magnitude and importance. We might consider them separately as pertaining to the three great natural physical divisions of India.

The Peninsula of Deccan

The Deccan plateau is one of the oldest and stablest blocks of the earth's surface, in comparison with the Himalayas which represent a weak and flexible part of the earth's circumference and which have been uplifted very recently. It has resisted all folding movements since very early geological times and is only susceptible to block-faulting or fracturing. Although no revolutionary changes have occurred in the Deccan plateau since the end of the Tertiary era, Tertiary Deccan had a drainage system different from the present one. Ordinarily we should find the drainage in a land of such antiquity to be more or less equally divided on the two sides of a central, dividing highland, but in the Deccan we find almost all the rivers flowing east from the Western Ghats which are situated so close to the Arabian seaboard. The rivers Tapti and Narbada are the only exceptions and they are flowing along lines of dislocation (rift-valleys). It is probable that the Deccan plateau extended much farther to the west and that the Western Ghats formed the watershed of that land, being situated somewhere in the middle; the land west of the Ghats has since subsided underneath the sea. Some evidence of this is observed in the scarped face of the Konkan and Malabar coast showing extensive faulting, the faults being connected with the system of faults seen in the Mekran coast, the south Arabian coast, and the African coast from Cape Guadarfui to Zanzibar. The rivers Tapti and Narbada do not flow in valleys of their own excavation but have occupied rift-valleys or cracks in the crust which follow more or less a straight line. The presence of numerous water-falls in the Narbada and in many other rivers of the Deccan also suggests a mechanical origin of the valleys which can only be explained by late tectonic disturbances. Some tilting of the peninsula towards the east took place simultaneously with the formation of the faults. This theory explains the position of the watershed and the easterly drainage of the rivers of south India.

The Indo-Gangetic Plains

Between the Deccan peninsula and the Himalayas is the vast flat expanse of the Indo-Gangetic plains—a sunken trough extending from Sind to Assam—filled up with the alluvial deposits of the rivers belonging to the Indus-Ganges system. The Indo-Gangetic plain was originally a deep rocky basin and was at first occupied by an arm of the old Himalayan sea, which in course of time gave place to a gulf and ultimately to the broad valley of a river which flowed across north India from the east to the north-west. This sunken trough is believed by geologists to have been created as a complementary depression to the elevation of the Himalayas. The earth's crust is so yielding that the waves of tectonic folding from the north created in front of the rising mountains a depression of the nature of a "foredeep". Sir Sidney Burrard, late Surveyor-General of India, considered it as a rift-valley, a crack in the earth's crust some 20 miles deep. Geologists have not accepted this rift-valley origin of the Indian plains. They consider the depth of the alluvial basin to be between 15,000 and 20,000 feet. Recent gravity measurements and other data indicate that the depth of the trough is not uniform; the maximum depth occurs between Delhi and Rajmahal Hills and that it rapidly decreases in Rajputana on the west and in the Rajmahal-Assam tract in the east, these regions having only a shallow, alluvial cover. According to this view, the peninsula has merely sagged and not fractured and the resulting trough is of the nature of a synclinal fold or basin and not a rift. Its filling-up has been accomplished by the simple process of alluviation, by the discharge of the silt and debris brought down by the rivers descending from the newly upheaved mountains.

The great plains of the Punjab, United Provinces, Bihar, and Bengal are thus of very recent age and are merely the offspring of the Himalayas. The silt-carrying capacity of Indian rivers is well known. It has been estimated that the Ganges transports about 900,000 tons of silt every day, while the Indus and Brahmaputra carry to the sea about 1,000,000 tons per day, on an average. This trough, vast as it is, could thus be filled in a comparatively short period of geological time. The loading of a comparatively narrow belt with nearly four miles depth of alluvium may presumably have affected the isostatic equilibrium of the trough and led to its further sinking; thus deposition and downwarp proceeded *pari passu*, and is probably still continuing *in the deltaic tracts of the Indus and the Ganges.* There are many evidences to prove the recent subsidence of the Sunderbans and of the tract of deltaic country below Hyderabad in the Indus valley. The Himalayas, on the other hand, receive further impetus for uplift by the continuous denudation and removal of matter from their surface by the rivers.

Evidences of Recent Geological Changes in the Himalayas

The most striking evidence of recent geological changes in the Himalayan region is furnished by the alluvial mounds or platforms known as *Karewa*, the uneroded portions of a once-extensive lake deposit which filled the Kashmir valley from end to end. The Karewas are several thousand feet in depth and contain many fossilized remains of prehistoric mammals and sub-Recent dicotyledon plants. Benches and terraces of Karewas adhering to the north-east flank of the Pir Panjal are tilted, folded, and elevated 4,000 to 5,000 feet above the present bed of the Jhelum. This is due to the uplift the Kashmir Himalayas have undergone since the time of formation of the Karewas (Pliocene to Middle Pleistocene) as deposits of the old Kashmir lake or lakes at the head of the Jhelum.

The second evidence of a recent uplift is afforded by the foot-hills of the Rawalpindi district which have infolded a considerable bulk of uppermost Siwalik strata (Lower Pleistocene). Boulder-conglomerate beds of this horizon, of great thickness, are vertically folded in these foot-hills, containing mammalian fossils which indicate a Lower or even, according to some paleontologists, a Middle Pleistocene age.

The deep dissection of post-Tertiary deposits by the numerous transverse rivers of the Himalayas affords yet further evidence to the same effect. Most Himalayan rivers have a system of river-terraces or benches which range up to about 3,000 feet above the level of their present beds, *e. g.*, the upper Sutlej. In some cases these terraces have entombed in the silt and gravels bones and other recognizable relics of Pleistocene mammals, indicating that the mountains have been elevated some thousand feet since the Pleistocene.

Recent Drainage Changes in Northern India

Indian geologists have long believed that the river Ganges was once flowing in a north-west direction and has only reversed its flow only in prehistoric times. During very late geological epoch a great river flowed from Assam to the Punjab and Kohat, thence, turning southward, flowed into the Sind Gulf prolongation of the Arabian Sea. Before the birth of this river, in Tertiary times, a gulf, known as the Nummulitic sea of north India, stretched from Sind to Assam. This sea was the last remnant of the Himalayan sea driven back by the uprise of the mountains from its bed. The existence of this postulated gulf is proved by the deposits left behind by it—deposits that were laid down on its floor in a thick pile of *Nummulite*-bearing limestone—in chain of outliers all along the foot of the Himalayas from Assam through Nepal, Naini Tal, Simla, to Kohat and thence, with increasing volume and breadth of outcrop, to Sind. This gulf as it retreated and disappered in course of time was replaced by a wide river running from east Assam to Punjab and thence southward to Sind. This old river, the predecessor of the present Ganges and Indus, is named "Indobrahm" by Sir Edwin Pascoe and the "Siwalik River" by Dr Pilgrim. The course of this ancient river is revealed to-day to us by the alluvial deposits it laid down on its banks and flood-plain. These increase in width and volume as we go westward of Assam, till something like 16,000 feet of a well-bedded pile of Siwalik strata are met with in the Soan basin of N. W. Punjab. The river Ganges, as we know it to-day, is a dismembered part of the Siwalik river of Assam-Punjab-Sind and owes its origin to a differential elevation taking place near the Panipat region of east Punjab, at the end of the Middle Pleistocene when the topographic evolution of north India was all but complete. This disturbance severed the Indobrahm into two portions : the upper half, the present Ganges, was deflected and followed an easterly course along the now flat and levelled plains and ultimately discharged into the Bay of Bengal, while the other, the lower half, continued to follow the north-westerly and then southerly course discharging into the Arabian Sea. The latter has become the Indus river of the present time. We cannot enter into the details of process of dismemberment, the repeated beheading and capture of the older rivers by the tributaries of vigorous young rivers which were involved in these changes. For these I would refer to the papers by Pilgrim and Pascoe on this subject : (Early History of the Indus, Brahmaputra and Ganges—Sir E. H. Pascoe, *Quart. Jour. Geol. Soc.*, Vol LXXV, p. 136, (1919), and Suggestions Concerning the History of the Drainage of Northern India—G. E. Pilgrim, *Journ. As. Soc. Beng* N. S. Vol XV, p. 81, (1919). The river Jamuna was at first an affluent of the Indus as it took a westerly course and crossed the Bikaner desert to the south-east by a now neglected channel that is well known in Hindu traditions under the name of the Saraswati river. Later on a tributary of the Ganges captured this stream and drained it eastward. In the east, another tributary of the Ganges beheaded the Brahmaputra (which is really a Tibetan river that had broken through the Himalayas) and made it flow south into the Bay of Bengal.

The Punjab portion of the present Jhelum, Chenab, Ravi, Beas and Sutlej has originated after the uplift of the Upper Siwaliks and subsequent to the severance of the Indus from the Ganges. The mountain-building movements to the north could not but have rejuvenated the small southern rivulets of the Punjab which emptied into the old river during Siwalik times. The vigorous head-erosion resulting from this impetus enabled them to capture, one after the other, that portion of the Indobrahm which crossed N. W. Punjab on its way to the Indus. Ultimately their head-waters joining up with the youthful torrents descending from the mountains, these rivers grew much in volume and formed these five important rivers of the province, having their source in the snows of the Great Himalaya Range and deriving their waters from as far east as the Manasarovar Lake on the Kailas range. The broad but deserted channel of the main river of Siwalik times, after these mutilating processes, has been occupied to-day by the puny, insignificant stream of the Soan (of Rawalpindi and Attock districts), a river out of all harmony with its great basin and the enormous system of deposits with which its bed is encumbered.[*]

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[*] Based on the author's Extension Lecture delivered under the auspices of the Faculty of Science, Lucknow University, on December 15, 1936.

Abbot's Solar Heater

Dr C. G. Abbot, Secretary of the Smithsonian Institution, having a lifetime of experience in measuring the sun's radiation and the flow of heat, has made various experiments in the last twenty years as a contribution to the age-long problem of using solar heating for power, cooking, and other purposes. His studies have culminated in an efficient machine demonstrated at St Louis, December 30, 1935, which was also demonstrated at the World Power Conference, held at Washington in September 1936.

The energy of the sun's rays which would fall at sea-level on a cloudless day on a square yard of surface at right angles to the rays, turned completely into mechanical work, would slightly exceed one horsepower. But many losses occur. Of these, the greatest single one results from Carnot's theory of the perfect heat engine. It is shown that the greater the range of temperatures employed, the greater the efficiency. Hence the effort has generally been to reduce heat losses and concentrate solar rays so as to raise a very high working temperature in the solar engine.

But this hitherto has involved large and costly heat-collectors and associated apparatus. Though solar rays cost nothing and are available to at least a thousand times our total present consumption of coal, oil, and hydroelectric power for all manufacturing, heating, and lighting requirements, solar power has hitherto been unable to compete economically with these other sources.

Dr Abbot's improvements lie first in the cheap, yet accurate and efficient ray-collector employed, and second in the highly efficient and heat-saving absorber for the collected rays. He employs a parabolic cylindrical mirror of "Alcoa" sheet, a commercial product of the Aluminum Company of America. This comes in large sizes as a flat thin sheet of very light specific gravity, reflecting over 80 per cent of solar rays, and so permanent in surface that a year's exposure to the weather makes no appreciable deterioration. A simple metallic framework of aluminium and duralumin makes up a cradle of the exact parabolic curvature required. He prefers the curve whose equation is $y^2 = 30x$. To this frame the "Alcoa" sheet may be screwed down without previous forming. Experiment shows that a present unit mirror with a 2-foot wide sheet about 6 feet long will bring the sun-rays to a focal line no wider than a lead pencil.

ABBOT'S SOLAR HEATER

At the focus the rays pass through two concentric tubes of "Pyrex" glass of 1-1/4 inch and 7/8 inch diameters respectively till they reach a central 1/2 inch "Pyrex" tube metal plated on the top third of its circumference, and within which flows a black liquid called "Aroclor". This liquid is a chlorinated diphenyl compound made by the Monsanto Chemical Co. of St Louis. With the addition of a very little lampblack it almost totally absorbs the focussed solar rays, and though still liquid when reduced to ordinary temperatures, it does not boil or flash at 350° C (662° Fahr.). A high vacuum is maintained between the tubes so that heat is lost only by radiation, as in a thermos bottle.

A flow of the liquid is maintained either by gravity circulation (as for the water boiler of a domestic furnace) or by a pump. Thus the heat absorbed from sun-rays is carried away to the apparatus for steam power (such as a tubular boiler), for cooking (such as a reservoir with inserted ovens), or for evaporating liquids (such as an open coil).

Experiments and theory agree in promising an overall efficiency of 15 per cent for steam power production. This contemplates a boiler at 200° C so that its maximum theoretical thermodynamic efficiency is about 40 per cent. Losses by reflections, inefficiency of steam engine, etc., bring the final figure to 15 per cent. This is a very substantial improvement on previous sun-motors. Ackermann, in "Utilization of Solar Energy" (*Smithsonian Annual Report*, 1915), claims 183 square feet per brake horsepower as the best output of the solar power station of "Eastern Sun Power Ltd." near Cairo, Egypt, in 1913. It is computed that with equal sun-intensity the Abbot machine will require but 60 square feet per horsepower. Ackermann goes on to claim practical equality in economy with coal at £3 10s per ton. If so, the present machine could compete with coal at £1 3s per ton, if the relative cost of the machines are equal. But here again there is a marked saving in the greater simplicity of present construction.

A half-horsepower steam-raising model is in construction. Whether a substantial proportion of the world's power demands will be taken on by sun-power within a few years is doubtful, but it is believed that if it were required, the power field might be filled by sun-power at little, if any, advance in cost with present appliances. This would, of course, require co-operating storage of power. The most obvious, though very costly, method is through the storage battery. Another is by pumping water to a reservoir on an adjacent hill or mountain. A third is by chemical synthesis of active agents, as by the decomposition of water. A fourth has been suggested in which heat itself is economically stored.

Symposium on Nutrition

MUCH interest was displayed in a symposium which was held at a joint meeting of the sections of Medical and Veterinary Research, Physiology, Agriculture, and Chemistry to discuss the subject of 'Nutrition in relation to crops, human beings and farm live-stock' on the 4th January at the Indian Science Congress Session at Hyderabad. Col. A. Olver presided and Sir Akbar Hydari was present. Dr W. R. Aykroyd, speaking from the stand-point of human nutrition, said that there was ample evidence for malnutrition, both qualitative and quantitative, in India. A large number of people, from observations in South India, appear to suffer from semi-starvation. There is a deficiency in calories, in protein as well as in vitamins and minerals, and certain deficiency diseases were common. The solution would lie in the direction of increasing the food-production, provision of unmilled or lightly milled rice, animal food-products, like milk, eggs, and fish, stimulating the production and consumption of pulses, green vegitables, and fruits, and of red palm oil.

Rao Bahadur B. Viswanath, speaking from the agricultural side, stressed the question of the production of more food, as the present food-production in India meets the demand of only two-thirds of the population. He also emphasized the effect of sunlight, particularly on calcium assimilation, and discussed the effects of nitrogenous and phosphate manuring on the food-values of the crops.

Major S. L. Bhatia drew attention to the standards set by the Health Organization of the League of Nations and the ill-health caused by inadequate and faulty nutrition among pregnant and nursing women. He also wished that the effects of the tropical climate on intervals between meals and of vegetarianism on physique and food-requirements were studied. He pleaded for generous support of such work by governments, municipalities, and private individuals.

The animal husbandry aspect of the question was discussed by Dr K. C. Sen, who stressed the difficulty of raising both food-crops and fodder from the small amount of land per head in this country. He stated that, although indigenous cows yield relatively small quantities of milk, experiments had shown that they have a latent milking capacity of a high order, which may be brought out under proper feeding conditions. Further work should be carried out, he said, on the maintenance, resistance to infection, and productivity of cattle.

Dr Wright of the Hannah Dairy Research Institute of England said that the main question of nutrition in India lay in the provision of larger quantities of better milk. That seemed to be the crux of the problem and he hoped that the dairy industry in this country would be given much greater attention than hitherto.

The biological values of the proteins of rice and pulses were discussed by Dr K. P. Basu and he pointed out the supplementary relation between milk proteins and cereal proteins and the value of soya bean as a supplement to milk. Mr Wad discussed the effect of green manuring on the nutritive value of wheat.

Prof. B. C. Guha said that investigations carried out at the Indian Institute for Medical Research, Calcutta, and at the University of Calcutta, on the diets of students' hostels and of middle-class families in Calcutta revealed a deficiency in protein of high biological value, of calcium and of vitamins A- and B-complex. All these deficiencies could be corrected by the provision of more milk. He also referred to the recent researches showing the presence of large quantities of vitamin C in some common Indian fruits like the guava, the mango, and the lichi. Prof. Guha stressed the need of more effective co-ordination between the work on human nutrition, on animal nutrition, and on agriculture in different parts of the country, and referred to the formation of the Indian Nutrition Committee under the auspices of the Science Congress last year, with these objects. Prof. V. Subrahmanian and Dr Mehta also joined the discussion.

Sir Akbar Hydari in a very notable speech expressed appreciation of the valuable work that is being carried on in this country on these lines. He said that, as an administrator, he considered such problems to be the basic problems of Indian administration. There is a lack of balance in administration itself, he remarked. The whole policy of administrators should be orientated in the direction indicated in the symposium. This is a basic problem to which public funds should be contributed in the largest measure.

Col. A. Olver, in winding up the discussion, again stressed the paramount importance of the provision of pure milk. He advocated a system of balanced crops, in which food-crops and fodder should be given proper importance. Dairying, he remarked, has been very much neglected in this country, which should be greatly stimulated, and he also pleaded for greater attention to poultry for the provision of the protective foods.

Surya-Siddhanta

Translation of the Sūrya-Siddhānta by Rev. E. Burgess. Reprinted from the edition of 1860. Edited by Phanindralal Gangooly, with an introduction by P. C. Sengupta. Pp. lvi + 409 + 11 + large map. Calcutta University.

Students of Indian astronomy and of ancient Indian culture will feel grateful to the Calcutta University for bringing out this reprint of Burgess's translation of the *Surya-Siddhanta.* This *Siddhanta* is the basis of all almanacs calculated to-day in the orthodox style, and, as Prof. Sengupta puts it, no student of Hindu astronomy would be deemed well equipped for research without thoroughly mastering it. In addition to the translation, Burgess's book gives a clear and complete exposition of the various rules, together with illustrative examples. Burgess spent fifteen years in India, and had the co-operation of various Indian Pandits well versed in Hindu astronomy, and of the Professor of Mathematics in the Sanskrit College at Poona. The work was edited by Prof. Whitney, and was published originally in Vol. VI of the *Journal* of the American Oriental Society. It is almost impossible to obtain a copy of it now. Hence the reprint under review is very welcome.

The utility of the work has been enhanced by the able introduction written by Prof. Sengupta, which gives in about 45 pages a short history of the *Surya-Siddhanta,* as far as it is possible to trace it. The data being meagre, opinions are bound to differ, specially as regards the extent to which Indians were indebted to foreigners for their knowledge of astronomy. Prof. Sengupta comes to the conclusion that although scientific Hindu astronomy is dated much later than the time of Ptolemy, barring the mere idea of an epicylic theory from outside, its constants and methods are all original. This seems to be substantially correct.

The internal evidence of the text gives distinct support to the theory that it is a composite growth, that it has been altered from time to time, and that there was some foreign element in it. The introductory stanzas state that a great demon (*asura*), named Maya, being desirous to learn astronomy, practised the most difficult penance, the worship of the Sun, who was so gratified by these austerities that he deputed a person, who was a part of himself, to impart to Maya the secrets of the science. Some texts of the *Surya-Siddhanta* have the following verse after this :

तस्मात्त्वं स्वां पुरीं गच्छ तत्र ज्ञानं ददामि ते ।
रोमके नगरे ब्रह्मशापान्म्लेच्छावतारधृक् ॥

"Go, therefore, to Romaka-city, thine own residence ; there, undergoing incarnation as a barbarian, owing to a curse of Brahma, I will impart to thee this science."

As all the manuscripts do not contain this verse, it is regarded as an interpolation. But even then, there must have been some tradition in the time of the interpolater that much of the matter of this Siddhanta was of western origin. Even in the absence of this verse, we may suspect some such thing, on account of the science being revealed first to a *mahasura* instead of to a *maharshi.*

Two verses after this we have, "This is that very same original *shastra* which the Sun of old promulgated, only by reason of the Ages, there is here a difference of times"

This give a clear indication that the work as we have it at present is a revision of some older work. This conjecture is amply confirmed by other evidences. In his *Pancha Siddhantika,* Varahamihira gives a summary of the *Surya-Siddhanta,* but his version differs from the present *Surya-Siddhanta* in the fundamental constants, showing that it must have been revised at least once after Varahamihira (550 A. D.). From internal evidence alone Burgess came to the conclusion that the superior limit to the date of the *Surya-Siddhanta* was 490 A. D. and the lower limit 1091 A. D. Prof. Sengupta believes that the *Surya-Siddhanta* is a composite growth dating from about 400 A. D. to about the middle of the eighth century: the lower limit might be even 1091 A.D.

The appearance on the title page of the announcement "Edited by Phanindralal Gangooly, M.T., B.L., raises hopes which are not fulfilled. The editor has contented himself merely by computing one solar and one lunar eclipse with (*i*) the elements and the methods of the *Surya-Siddhanta* and (*ii*) with modern elements, but with the methods of the *Surya-Siddhanta*. He also gives the results of modern calculations for the same eclipses. This gives an interesting comparison. In the case of the lunar eclipse the methods of the *Surya-Siddhanta* are sufficiently accurate, differences from truth of the results based on it being almost nil. In the case of the solar eclipse, difference is about 5 minutes. If, however, the elements are calculated in accordance with the precepts of the *Surya-Siddhanta*, the error amounts to as much as an hour and a half in the time of the last contact in the lunar eclipse. This is but natural, seeing that the *Surya-Siddhanta* takes as its 'epoch' the 18th of February, 3102 B. C.

But one expects much more of an editor. To the reprint of Burgess's translation should have been added comparative notes at all places where the translation has been improved upon by later workers. This would have made this work far more valuable. In the introduction by Prof. Sengupta one inaccuracy in Burgess's translation has been pointed out, but this is done simply because the author happens to discuss that particular verse.

Though clearly printed on good-quality paper and neatly bound, the book cannot be classed among really got-up volumes by reason of the very heavy impression used in the printing, and on account of the crude diagrams. The reviewer wonders why the beautiful original diagrams were not reproduced by the photo-mechanical process. As it is, the diagrams have been copied by an inexpert hand, and most of the diagrams contain actual errors. Thus, in Fig. 6, p. 83, instead of producing BP to meet the circle in *x* (as in the original), QP has been produced, and *x* has been written so far away that one cannot guess what point it denotes. Again, Fig. 8, p. 101, is wrongly oriented. SN should have been horizontal. Even a layman could have seen this, because the lettering is not upright in the diagram as printed. In Fig 21. p. 152, the circle with centre O *cuts* the circle of shadow, whereas it should *touch* it, as in the original. In Fig 5, p. 77, the letters O and *o*, are printed alike, as also *C* and *c*. Moreover, *c′* is shown as *c*, and *b* as *b′*. In Fig, 3, p. 72, the distinction between the fine and heavy lines of the original has been partly obliterated, and partly misapplied. Most of the other diagrams are similarly defective. However, they do not spoil the utility of the book.

The University of Calcutta, the Editor, and the author of the introduction have done a signal service to the cause of Indian astronomy and they deserve our thanks for making accessible to us a rare and useful book.

Gorakh Prasad.

Some Plant Diseases and Pests of India and their Control

Anil Mitra
Botany Department, University of Allahabad.

PERHAPS it is not commonly known in India that plants are as liable to disease as human beings and other animals. The probable reason for this ignorance is that the plants are generally motionless and the diseased condition, not being always immediately fatal, often remains unnoticed. It is also to some extent due to lack of considerable effort to disseminate knowledge about plant-diseases. Plants are of the greatest economic value to us, for life ultimately depends on them. Any factor, there fore, which tends to reduce the yield from the plants should receive our careful attention. It has been said that in the cost of every half-a-dozen shirts that a man buys is included the price of the seventh lost due to the diseases in the cotton fields. Masse estimated in 1912 that the annual loss to the world due to only one of the agencies enumerated below (Fungi) exceeded 150 million pounds and added that probably double the figure would be nearer the truth. India contributes a very high percentage to this appalling waste. It has been estimated on a conservative basis that the annual loss to the country due to a particular disease (rust) of wheat is more than 4 crores of rupees. Butler once computed that the smut disease of Jowar, in which the grains become filled with a black dust, annually costs the Bombay Presidency over 15 million rupees and remarked that "practically the whole of this is preventable". Our poor country can ill afford to neglect such losses for long and we should utilize our kowledge and resources for the prevention of at least the more important of the preventable plant diseases.

Symptoms

Disease in plants may be considered as deviation from their normal structure, function, and produce. The following are some of the symptoms which can be commonly recognized :—(1) wilting – the whole plant withers though water may be abundant in the soil. When seedlings are attacked there is a sudden collapse and the disease is known as "damping off". (2) Leaf spots—which may vary in colour and size ; (3) shot-hole—the leaves become perforated as if they have been shot through; (4) discolouration—the entire plant or parts of it may become pale and yellow instead of retaining the bright green colour ; (5) curling and mottling of leaves ; (6) gradual drying and death of the parts often accompanied by dropping of fruits ; (7) dwarfing ; (8) hypertrophy or excessive growth of the parts often resulting in galls, tumours, deformed fruits and branches, witches' brooms and alteration in symmetry ; (9) wounds on woody stem called "cankers" or on the surface of fruits known as 'scabs'; (10) exudation of liquid; and (11) rotting which may be either dry or wet. A particular disease may produce only one or many of these symptoms. Often, however, a direct diagnosis of the casual agent by symptoms alone cannot be made as the same symptoms may be due to several causes. It is so easy to cut the diseased part and to study the parasite responsible for the disease without causing the plant to die, that symptomology has not been carried to the same perfection as has been done with animals and men where such a procedure is often impossible.

Agents

Leaving aside the ancients' belief that they are caused by supernatural powers like the wrath of the gods or the influence of the stars, plant diseases are known to be due to the following chief agents :—(*a*) Parasitic plants—which may be minute and often microscopic like the fungi, algae and bacteria or flowering plants such as the golden creeper (dodder, swarna-lata), broom-rapes (Tokra) etc.; (*b*) parasitic animals like the insects and worms; (*c*) infectious principle called "virus" in which no organism has yet been demonstrated; and (*d*) "physiological" diseases due to deficiency in nutrition and other causes. By far the most serious and well-known plant diseases are due to other plants known as "Fungi". It is difficult for the layman to stretch his idea of the ordinary plants to members of this group but nevertheless they are plants. These are minute, often microscopic organisms, the familiar examples being the mushrooms or toadstools and the white or coloured moulds that appear in the rainy season on decaying fruits, jellies, wood, and even on leather. The fungi commonly reproduce by minute bodies called 'spores' which function like the seeds.

Control Measures

To successfully prevent the disease it is absolutely necessary to know exactly how the parasite lives and when it reproduces so that the methods of control may be applied to the most vulnerable point in its life-history. The measures of control generally adopted may be either direct or indirect. The direct or therapeutic measures are: (1) Spraying of chemicals or dusting with sulphur or lead arsenate powders. One of the commonest sprays used is "Bordeaux" mixture, a 1% solution of which contains copper sulphate (bluestone)-5 lbs and Quicklime-5 lbs in 50 gallons of water. This method, which is used where the parasite lives on the surface of the plant or comes out for reproduction, is of limited application in India, because it requires care in preparation, is to be done at the right moment when the parasite is about to reproduce, is to be applied to the right parts and is to be repeated if sudden rain washes it away—and these are hardly to be expected from the uneducated masses. (2) Disinfection of soil by steam, electricity or chemicals. This is too costly and complicated to be used in this country at present. (3) Disinfection of seed and other propagating stock by chemicals such as formalin or copper sulphate or by proper heat. And (4) disinfection and protection of wounds by smearing with coal-tar or other substances. Most of the direct measures being unsuitable for India, indirect or prophylactic measures are often resorted to. These are:—(5) mixed crop—most of the parasites cannot grow on more than one kind of crop. The chances of infection from a diseased plant, therefore, is minimized if similar plants are separated from each other by other crops which the particular parasite cannot infect. This is quite an easy method and is widely practised in India. (6) Rotation of crops—in the absence of the particular crop, the parasite, which may live in the soil from the crop of the previous year and which cannot grow on the crop of the present year, is starved to death. Generally a three years' rotation is practised. (7) Removal and burning of dead and diseased parts or individuals to destroy the source of infection. (8) Use of disease-free and healthy seeds, cuttings, etc., which may be obtained from well-cared-for seed plots and nurseries. (9) Early or late crops are sometimes useful as the parasite is often not very active except during a certain period of the season. (10) Removal of other hosts on which the parasites may continue to live when the normal host is not present. (11) Avoidence of injury. (12) Proper storage conditions—fruits, potatoes, etc., should be stored in a dry, cool, well-ventilated place and only in one layer not touching each other. (13) Proper soil conditions—a heavy or water-logged soil or its high acidity or alkalinity is harmful. (14) Proper manuring, excess of nitrogen and lime is injurious. Fresh farmyard manure may contain reproductive bodies of some parasites which pass uninjured through the stomach of the cattle. (15) Planting of resistant varieties—the drawbacks of this method are the difficulty in their production, the loss of their resistance after a time and the susceptibility of many unacclimatized imported resistant plants. (16) Use of harmless antagonistic organisms—the parasite which damages the crop is deliberately infected by an organism which harms the parasite but not the crop. Locusts in Africa are said to be deliberately infected and killed by a fungus which, however, when given a trial in India, failed to injure them. (17) Legislative control—certain diseases are un-intentionally introduced along with plants and these are often most virulent. Imported plants should be subjected to quarantine laws. The Destructive Insects and Pests Act (1914) regulates the import of seeds and plants into British India, and in the Bombay ports, these are fumigated with hydrocyanic acid gas. This measure is good for insects, but unfortunately rarely affects the fungi.

India is a vast country and there are few areas which bear such a variety of crops or where these are grown under greater variety of conditions. It is natural, therefore, that the number of diseases found here is very large and many of these have not yet been thoroughly studied. Moreover, there are many indigenous diseases for which knowledge gained from outside is not available.

Obviously it will be impossible in the compass of this article to mention all or even most of the well-known diseases and so only a few of the more important and interesting ones will be described together with the means to prevent them.

Diseases of the Vegetables

In the serious blight disease of potato there is at first a white haze on the leaves. The diseased areas enlarge rapidly and become darker in colour till the whole plant is blackened and killed, after which the underground potatoes are rotted and a characteristic foul smell is given off. The spread of the disease is so rapid and the destruction so complete that it was responsible for the great Irish famine of 1845 when by almost completely destroying the staple food of more than 4 million people, it reduced the population by one fourth. Though known in Europe for a long time the disease did not reach India till 1870-80 when from the imported potatoes it first appeared in the Nilgiris. In 1883 it broke out in Darjeeling due to introduced English varieties and spread rapidly throughout the Himalayas. In the Khasi Hills, Assam, the cultivators felt so helpless as to give up growing potatoes. The parasite (*Phytophthora infestans*) lives in the soil on dead infected parts that are left there, so these should be removed and rotation of crop practised. Spraying with Bordeaux mixture gives wonderful results. In the Khasi Hills in 1906 it was estimated that profit over the cost of spraying (Rs 12-13 per acre) was over Rs 50 in an acre. Fortunately the parasite is killed by a temperature of 90° F and so cannot survive the summer heat of the plains where it is unknown. A severe epidemic, however, was reported from Rangpur and Bhagalpur in 1913 and on enquiry was found to be due to diseased potatoes imported from the hills in winter for seed. The same mistake was done in 1924 and considerable damage was done to the crop in Patna and Dinapore.

A sudden wilting of potatoes is caused by bacteria (*Bacillus Solanacearum*) and is known as the ring disease, because the potatoes show a brown ring if cut through, and ultimately the whole of it is rotten. The disease recurs through the use of infected tubers or by raising the crop on infected soil. Great loss is caused annually by the rot of potatoes in storage. In U. P. it is about 50 lakhs of maunds yearly and in Shillong 20 % damage was noticed after only two and a half months' storage. It is due to two fungi (*Fusarium* and *Rhizoctonia*) and a bacterium. A dark brown insect (moth) is also responsible for much damage in the beginning of the rainy season and in worst cases the loss may reach up to 100 %. To prevent this waste, napthalene or fumigation with petrol may be used, but the best way is to store the potatoes in a cool, well-ventilated place in one layer, not touching each other, and then to cover them with thoroughly dry sand. The potato mosaic, a virus disease, causes a loss in U. P. up to 5% of the crop. The leaves show patches of yellow colour and it is best to remove and burn the infected plants.

It is a common sight to see large numbers of withered and dead brinjal (Begun) plants in the fields, which after death are invaded by white ants. Their death is due to a borer caterpillar which comes out from the dead plants to infect the healthy ones. The withering plants should therefore be uprooted and burnt without delay.

The commonest fruit-rot of this plant is due to a fungus which appears as black dots. The plucking and burning of diseased fruits satisfactorily check the spread of the disease. The tomato plants are affected by the same blight and bacterial wilt as potato and the fruit-rot of brinjal and the treatments are similar.

The blight (*Phytophthora*) of kachu is very common and often serious. In August 1931 at Allahabad a whole crop was literally wiped out by it. There are at first small, dark, roundish specks on the leaves which enlarge rapidly into roundish patches in which rings can be seen. The corms (kachu) may be entirely lacking or if formed are small and shrunken. Selection of sound kachu for planting, burning of diseased leaves, rotation of crop, and spraying with Bordeaux mixture are the control measures. The cucurbits are attacked by white powdery mildews which can be checked with sulphur dusting.

(*To be concluded*)

Rao Bahadur T. S. Venkatraman, the General President at the last session of the Indian Science Congress, held at Hyderabad in January 1937.

Notes and News

New short-Wave Transmitters for India

The Government of India has lately decided to provide Calcutta, Delhi, Bombay and Madras with ten-kilowatt short-wave transmitters instead of five-kilowatt ones as previously decided. This increase in power has been possible on account of the tenders received being much below the previous estimates. The broadcasting authorities now recognize that in India where atmospheric disturbances are more severe than in Europe, short waves would be more effective and useful than medium waves. For local broadcast, however, medium waves are essential and the city of Madras which, unlike Calcutta, Delhi, and Bombay, is not already fitted with a medium wave transmitter will therefore have a 200-watt medium-wave transmitter. This will be installed on modern lines. The aerial system will be a single mast and thus provide a highly efficient radiator. The cost of such a mast-aerial will be considerably lower than that of the usual system of T-aerial supported by two masts. A novel feature in the design of the new transmitters, both short and medium-wave, will be the use of class "B" amplifiers which will greatly economize power consumption. The valves in all the transmitters will be of the latest type and will all be air-cooled. No water cooling system being necessary this will considerably simplify operation. It is expected that the first transmitting equipment will reach India next August and will be in operation a couple of months later.

New Electrical Lamps

Amongst the various interesting exhibits at the opening meeting of the Illuminating Society held in London on October 13, a new type of mercury vapour discharge lamp was shown. This lamp is similar to the frosted type of electric lamp, but it contains no filament. A small mercury vapour discharge lamp about an inch and a half in length is enclosed inside. The ultraviolet light from this mercury lamp illuminates a flourescent material which is coated on the inside wall of the glass bulb. The colour-corrected light from this fluorescent material was found to be very satisfactory. The light emitted by these lamps is about 40 lumens per watt and is over three times that emitted by the ordinary coiled coil lamps.

80 and 125 watt lamps of this type are available and their life is stated to be 1500 hours. It is expected that this type of lamps will be soon available for use and will considerably reduce the house lighting bills.

Another advance in the ordinary filament lamps is due to the use of krypton gas which is a poorer heat conductor when compared to the nitrogen-argon mixture now used in the gas-filled incandescent lamps. A krypton-filled lamp of 1500 lumens requires only 91 watts as against 100 watts in the case of nitrogen-argon lamps. The size of the krypton lamp is also smaller and though it costs 50 per cent more, the overall cost over the whole life of the bulb is a little smaller than the nitrogen-argon bulb.

The Essence of Galileo's Philosophy

Galileo is justly regarded as the harbinger of the new age in science. In a lecture delivered under the auspices of the Galileo Lodge of the Sons of Italy in America at Griffith Observatory, Los Angelos, on Feb. 29, 1936, Dr F. H. Sears quotes the following to show his attitude towards science:

> "It is not in ancient tomes, but in close observation and personal consecration that a grain of truth may be found. It is so very easy to seek the significance of things in the paper of this or that man rather than in the works of nature which, ever alive and active, are constantly before our eyes."

"There in a sentence is the gist of Galileo's great contribution", says Dr F. H. Sears, commenting on this. "That to provide the sound principles appropriate to natural science which were pre-supposed by Aristotle's teaching, we must turn to nature and by observation and experiment learn her laws. That the matter now seems so obvious is a part of Galileo's service."

NOTES & NEWS

Calcutta University Scheme

The most important problem that a University in India has to face to-day is the question of unemployment so rampant amongst its alumni, and steps are being suggested and considered in all provinces that will lead to the educated middle-class youths being employed as best as they can be. While an Unemployment Board has been recently formed by the Allahabad University with this end in view, the Calcutta University has before its senate the consideration of a scheme which will bring about closer co-operation between the University and the business houses of the city, providing particularly for practical training to selected graduates and under-graduates in different lines of trade, industry, and commerce, so that they may not think of service as the only means of livelihood, but be in a position to start their own business or be associated with trades and business houses in a manner advantageous to both parties. In a memorandum, Mr S. P. Mookerjee, Vice-Chancellor, Calcutta University, has outlined the whole scheme. He suggests that while the selected youths are working as apprentices, they should be paid a small monthly allowance of Rs. 30 during the period of their training which may be a year or more to enable them to meet their personal expenses. The allowances may be paid (*a*) by the University, (*b*) by the business-houses and firms to which the students are attached, (*c*) by charging fees from those youths who can afford, and (*d*) by public donations. Lectures outside the usual class-routine on practical subjects are being organized so that the students may be enabled to obtain first-hand knowledge of, and information on, practical problems concerning their subjects of study. Mr Mookerjee also speaks of the desirability of establishing a committee as the first step, whose function will be as follows: To select apprentices for practical training in technical and non-technical lines; to recommend to firms names of suitable candidates for appointment, when requested; to remain generally in touch with employers and to collect statistics and supply information; and to advise students preparing for competitive examinations and if necessary to organize their training.

The Ross Institute in India

The Ross Institute in India was established primarily to deal with the problem of malaria on tea estates in Bengal and Assam. It was amalgamated with the London School of Hygiene and Tropical Medicine in 1933. The Institute now maintains a staff in India to advise on health problems on the spot and provides the funds necessary to enable medical officers in industry to maintain field laboratories; finances training centres for Indian malaria surveyors and laboratory assistants; assists directors of companies in the selection of medical officers for overseas; provides a malaria-control course for laymen each year; provides a centre in London where medical officers on leave may have laboratory facilities and meet and discuss their problems with the various departments of the School, and also a centre in London where directors, superintendents and managers can come at any time and discuss the various health problems and any matters connected with sanitation on their properties.

The Institute has now to meet a wide demand for assistance and advice on all matters connected with health and sanitation, in addition to malaria, by practically every industry in the country. It is therefore proposed:

(*a*) That the incorporation of the Ross Institute in the London School of Hygiene and Tropical Medicine, which brings to the service of industry an immensely increased background of scientific knowledge, should be acknowledged by the pooling of the Central and India Branch funds, the Ross Institute continuing to guarantee to maintain staff in India;

(*b*) that the staff available for consultant service on matters of hygiene to industry in India should be increased to at least two; this will mean that there will always be at least one resident in India;

(*c*) that the service of the staff should be freely available to all industries, as well as tea, in India; and

(*d*) that additional funds should be subscribed by the various industries generally in the proportions in which they are likely to require assistance, either directly by the individual members, or through their Chambers of Commerce.

Mr. H. L. Stevens, Organizing Secretary of the Institute, who is now in Calcutta, will conduct the preliminaries necessary for the proposed improvement and extension of the Institute in India, especially the financial side of it, in which a reorganization is urgently called for, in view of the inadequacy of the monetary contribution received from India so far.

NOTES & NEWS

Dr R. C. Mazumdar

Dr R. C. Mazumdar, Professor and Head of the Department of History, Dacca University, has been appointed Vice-chancellor of that University.

D.Sc. Awards by Dacca University

Messrs Tarapada Banerji and Bhupendranath Mitra have been awarded the degree of Doctor of Science by the Dacca University. The thesis of Mr Banerjee was on the use of inorganic colloids as catalysts for photochemical reactions and that of Mr Mitra on the physico-chemical properties of the proteins of the cholera vibrio and of related species.

British Association Meeting for 1937

The 1937 Meeting of the British Association for the Advancement of Science will be held in Nottingham from September 1 to 9 under the presidentship of Sir Edward Poulton. The following sectional presidents have been appointed: A. *Mathematical and Physical Sciences*—Dr G. W. C. Kaye; B. *Chemistry*—Dr F. L. Pyman; C. *Geology*—Prof. L. J. Wills; D. *Zoology*—Prof. F. A. E. Crew; E. *Geography*—Prof. C. B. Fawcett; F. *Economics*—Prof. P. Sargant Florence; G. *Engineering*—Sir Alexander Gibb; H. *Anthropology*—Dr J. H. Hutton; I. *Physiology*—Dr E. P. Poulton; J. *Psychology*—Dr Mary Collins; K. *Botany*—Prof. E. J. Salisbury; L. *Education*—Mr H. G. Wells; M. *Agriculture*—Mr J. M. Caie.

The Death of Prof. G. Elliot Smith

The death has occurred of Sir Grafton Elliot Smith the wellknown authority on anthropology.

New Director General of Archaeology in India

Our heartiest congratulations to Rao Bahadur K. N. Dikshit M.A. who is to become the Director General of Archæology in India in succession to Mr J. F. Blakiston. Rao Bahadur Dikshit was appointed Superintendent of the Eastern Circle in 1920. In 1930 he was appointed Deputy Director General for Exploration and in 1935 Deputy Director General of Archæology. During his whole career he has proved himself to be a very able officer. He has successfully carried out archæological excavations at Mohenjo-daro, Paharpur, Mahasthan, Rangamati and a number of other places. He is not only an able excavator but also an expert epigraphist and numismatist. His researches in the domain of Indology are of high order and excellence. His appointment has been acknowledged with great satisfaction by all who are interested in Indian archæology. He is the second Indian to hold this high post, the first being Rai Bahadur Daya Ram Sahni. We wish him all success and a brilliant career.

Professor B. B. Ray

We regret to announce that one of our editors, Professor B. B. Ray, has recently resigned his editorship on account of ill health. Professor Ray was associated with this Journal from the very start and has rendered valuable service throughout his period of editorship. Whatever success the Journal has achieved is largely due to his hard labour and continuous care for its welfare. Our sincerest thanks are due to Professor Ray for the way in which he has so long conducted the Journal. We hope he will soon regain his health and be able again to help us actively.

Science in Industry

Agriculture in Ancient India

The Imperial Bureau of Soil Science has brought out for September 1936 in its Monthly Letter No. 59 a translation of *Krishi Sangraha* said to be compiled by that sage of old, Parasara. The original book is written in Sanskrit and the translation is by Dr. S. P. Roy-Choudhuri at present working at the Rothamsted Experimental Station: *Krishi Sangraha*, as the name denotes, is a short, and perhaps summary, compilation on agriculture in India. India is essentially an agricultural country and has been always so from times immemorial; no wonder, therefore, that it attracted the attention of the learned of early days, who tried by observations and experiments to generalize it into a science. The compilation is the result, no doubt, of such attempts. The booklet contains much about what seem to be forms and rituals, and auspicious and inauspicious days and planets and constellations of stars seem to have exerted a predominating influence on the mind of the author so much so that the author is greatly obsessed with it. Ceremonies played, as in every other walk of life of the ancients, a very important part, and these have been greatly stressed in the booklet. Some general rules for cultivation are incorporated and we believe that they wonderfully tally with those followed today by the peasants of this country, especially in Bengal. In giving rules for the sowing of seeds, the Sage says:

" The best month for sowing seeds in ordinary cases is *Baisakh* (April-May) ; *Jaistha* (May-June) is medium; *Asharh* (June-July) is bad: and *Sravan* (July-August) is worst. The best month for sowing seeds where transplanting is to be carried out is *Asharh; Sravan* is bad; and *Bhadra* (August-September) is very bad."

Then again, regarding the removal of weeds from paddy fields:

" If the weeds be removed during the months of *Sravan* and *Bhadra*, then even if the rice field be again filled with grasses, the yield of crop is doubled. If the weeds be removed from the rice fields twice in the month of *Aswin* (September-October), then there is considerable yield of crop like the pulse grain *Maskalai*."

For the indologist and the social anthropologist the compilation may be of some use in comparing the methods of agriculture as adopted by the present-day farmer with those of the ancients. They are as true in Bengal to-day as they were in the days when the book was written, and there is a suspicion in the reader's mind that the compiler, Mahamuni Parasara, was a native of Bengal!

Indian Paper Industry

In India out of nearly 300 fibre-yielding plants growing on the soil, only thirty may be regarded as commonly in use, though the Industrial Gallery of the Botanical Survey of India has a collection of 160 of these plants. They are utilized in a number of ways among which the manufacture of brushes, brooms, baskets, cordage, textile industry and paper-making are the chief ones. In the *Modern Review* of January 1937 Prof. K. K. Purkayastha contributes a thoughtful article, in which he gives an excellent analysis of the paper industry in this country and points out the need for the preservation of our indigenous fibrous plants. The paper industry on modern lines is comparatively of recent origin in India, though the first mill was started fifty years ago at Bally near Calcutta. It has made good progress ever since, but the outturn of the mills can hardly meet even half the demand of the country. Foreign papers from Europe, America, and Japan are imported in huge quantities. India imported paper and paste board from other countries to the value of Rs. 2,63,18,972 during the year 1933-34 and of Rs. 2,72,82,041 during 1934-35. These figures show what a brisk market India is for other parts of the world in respect to paper. Besides finished products, Norway, Sweden, U.S.A., and Japan do a very profitable trade with this country in pulp, which, being a half-finished product, enters the Indian ports at a lower rate of duty than what is imposed on imported finished paper. These facts bring home to our mind the urgent necessity of establishing the indigenous paper industry on a sound footing by first making a thorough survey of the fibre-plants in this country, conserving those existing, and checking their waste by proper legislation. Research must also be carried on for finding out how the fibre can be best utilized. The Soviet Government has a separate research department for this purpose. In India the only institution where research is carried on in this field is the Forest Research Institute, which being a huge organization, cannot possibly pay all the attention the paper industry would demand.

Small Dimension Stock

Rural uplift is now the declared policy of the Government and political bodies of this country and the village industry is receiving close attention. Various suggestions have been made both by Government spokesmen and our public men as to what should occupy the Indian peasant during his spare time and off-season. He is generally free from farming for eight months in the year which he can well utilize in various ways to supplement his income. The latest is that issued by the Forest Research Institute, Dehra Dun, in their booklet entitled *Manufacture of Small Dimension Stock: A new Rural Industry*. The expression, 'small dimension stock', generally means wood planking of small sizes that can be cut from slabs or trimmings, or pieces from small logs of branches of different sizes. The stock can be used on a large scale in the manufacture of a host of wooden articles, such as (1) agricultural implements like ploughs; (2) tonga and cart spokes, and their parts; wheel barrows, trucks, motor car bodies and wheels, etc.; (3) boxes, crates, barrels, poultry coops, sign and advertising boards, patterns, templates, tubs, water tanks, etc.; (4) sporting goods like the tennis and badminton rackets, hockey sticks and cricket bats, poles, etc.; (5) chairs, benches, stools, book-shelves, tables and other articles of furniture, etc.; (6) handles of brushes, brooms, cross-arms for electric poles, garden and machine tools etc.; (7) shuttles, spools, and bobbins, woodenware and novelties, toys, patterns, flasks, etc.; (8) small machines like spinning wheels, weaving machines, framework for sugarcane crushers, etc.; (9) doors, windows, ventilators, panel as well as trellis partitions, wall-brackets, shingles, casing for electric work and house-building components; and (10) miscellaneous small-sized wood-ware like door knobs, parts of indoor games, like chessmen, draughts, etc., curtain rods, shoe-lasts, paper-weights, blotters, cups and saucers.

The manufacture of all these articles requires small-sized wood pieces and practically every kind of wood, hard or soft, which is available from the forest, will be suitable. The initial capital required is very small, only as much as is necessary for the purchase of a hand saw and a wood axe. Thus there appears to be, indeed, a very wide field for the use of small dimension stock in wood industries of the country. At present the small dimension wood industry no doubt exists to a certain extent, but it must be built up on a more scientific, systematic, and extensive scale for the starting of a new rural industry of a far-reaching importance. It should be organized on a co-operative basis. It is also suggested in the booklet of the Forest Research Institute, above referred to, in which an outline of the scheme is given, that for the guidance and facility of the villager to find a ready sale for the product of his labour, a liasion salesman who could be trained at the Forest Research Institute, Dehra Dun, may be provided; that the villager should be saved the worry of finding a market for the small dimension stock he produces; and that he should be taught to produce sizes and shapes that would find ready sales in the towns and cities. The small dimension stock industry will not only reduce the timber waste to a minimum but will also engage the Indian villager during his spare time, for which he will gain materially. There is also little danger from machine competition, for while the products will be manufactured with inexpensive rural labour from waste timber, machine can never rival man for the exercise of the necessary judgment in cutting crooked logs at proper places and cutting out defective timbers with the minimum of waste.

Silk Industry in Bengal

One of the oldest indigenous industries of Bengal is the silk industry whose importance has greatly diminished in recent times due to competition of foreign countries, especially Japan and China, and also to the lack of Government's active interest in it. It used to be once one of the few chief industries, and it is a pity that such a profitable trade of the province should be allowed to decay. Mr. C. C. Ghosh, deputy director of sericulture in Bengal, in his wireless talk on the 4th December 1936, gave an analysis of the whole situation and enumerated with great care the various causes of the decline of the silk trade in the province. After giving an account of the process of silk-production, from the building of the cocoon by the worm to reeling and weaving, he referred to the cultivation of mulberry, the food of the silk-worm, in which Bengal now lags behind other countries, now that the latter have utilized the science of growing this field crop. "The inferior quality of Bengal cocoon is a great handicap for the Bengal industry and is one of the principal causes of its failure to compete with that of countries possessing superior cocoons." "Better races of worm are necessary as well as better forms of mulberry" in order to regain the lost ground or even to maintain the little market that it still enjoys. Secondly, a properly organized reeling industry producing raw silk with desirable qualities and offering a sure market for cocoons at a fair price is an urgent necessity. As there is no proper organization at present, the reelers and cocoon-producers are often victims of mean and inhuman exploitation by capitalists. and "there are complaints about unfair dealings and non-adherence to contracted prices." The third factor which has affected the industry is competition of cheap silks, both raw and woven, from China and Japan, where the industry is virtually a subsidized one. Apart from the various direct and indirect helps to the industry "the depreciated value of both Japanese and Chinese currency to the extent of about 50 per cent of the normal value amounts to an additional subsidy." The Bengal and Indian sericultural industry has thus to contend against very unfair competition and can hardly be expected to live without adequate protection. The necessities of the situation demand first of all adequate protection to the weaving as well as raw silk industry. No silk thread, according to Mr. Ghosh, should be allowed to be sold at less than 6 annas a lb. At the same time improvement in mulberry and races of worms and improvement and organization of reeling are urgent necessities. The industry has enough vitality and if only freed from the unequal and unfair competition, it will soon revive again.

Glycerine in India

M. N. Goswami

Lecturer in Applied Chemistry, Calcutta University.

India is a vast country. Her agricultural and commercial potentialities are immense. Some of the industries are recent but are rapidly growing. Let us take for example the soap industry; its growth is very recent. The demand for soap has gradually increased from 1876, when the import was valued at Rs. 3,32,791/-; the following were the subsequent figures:

1901—1902	Rs. 17,61,427/-
1902—1903	„ 22,67,801/-
1903—1904	„ 27,23,705/-
1905—1906	„ 31,90,890/-
1906—1907	„ 32,28,156/-

It is at this period that some factories cropped up, and although the consumption figure increased, the increase of import was somewhat steadied. Soap worth about 2¼ crores has been consumed in 1933-34, the import figure at this year being Rs. 78,37,362/-. India is still behind other countries as regards consumption as will be seen from the following:

America	25	lbs.	*per capita.*
Holland	24	„	„
Denmark	22	„	„
Great Britain	20	„	„
Rumania	4½	„	„
India	¼	„	„

If India's figure *per capita* becomes that of the lowest consuming country of the west the consumption figure would come up to about Rs. 40 crores. This really shows the enormous possibilities of expansion of this industry.

If we consider the consumption and import figures of 1933-34, we find that India produced soap worth Rs. 1,46,62,638/-. Taking on the average Rs. 14/- —Rs. 15/ as the price for soap per maund we find that India in the same year produced about 10,00,000 maunds of soap. Deducting from this about 15% for the average content moisture, the figure for anhydrous soap comes up to about 7,50,000 mds.

Roughly speaking 100 maunds of oil or fat require 20 mds. of caustic soda to produce 110 mds. of soap and 10 mds. of glycerine. On this basis it is found that India's potential capacity to produce glycerine in 1933-34 was 680,000 mds. or about 600,00,000 lbs. of glycerine. If India's consumption *per capita* becomes that of Rumania the total output of glycerine will in future come up to 1068,000,000 lbs.

Not a single factory in India is recovering this glycerine which is a bye-product in the soap industry. The soap lye, the liquor remaining after the soap is prepared, contains about 6—7% glycerine. It contains in addition 2—3% caustic soda and rest water, common salt and other impurities. In some factories this soap lye is again used in the preliminary operation for making soap and thus the caustic soda is utilized but after this everything is thrown away. Glycerine is used in medicine, in the preparation of cosmetics, in explosive industries, and in the preparation of plastics and many organic compounds. The soap lye after neutralization is concentrated in open pan up to about 80%. This is thick brown liquid known as crude glycerine. This is then concentrated in vacuum and distilled. In India explosive and plastic industries have not developed—the only use being in medicine and cosmetics. Only imported glycerine is utilized. (The import figure for 1933-34 being 11,855 cwt. valued at Rs. 3,76,740/-.) Many of the soap concerns in India are not big and the capital expenditure for installation of glycerine plant being appreciable and the consumption figure being not very tempting no factory cares to recover them. The price of caustic soda at port due to competition has now become Rs. 7—Rs. 8/- per cwt. Considering that India does not produce any caustic soda, she will be again at the mercy of the monopolist as soon as this competition factor is removed. Of late there has been heavy buying of cocoanut oil by foreign countries and its price has increased by 50%. This oil being a necessity in soap making it has undoubtedly affected the soap makers. So, for the future development of soap industries on economic lines the problem of recovering glycerine should receive our serious attention. So long as glycerine is used in explosive industries its price is bound to fluctuate and in war time sometimes prohibitive; so that it is not only for economy in soap industry, but also for glycerine itself that we should be careful in recovering it. The proposal has been for some time under the consideration of the All-India Soap Association and it has been suggested to have one company in every soap centre which will utilize all the soap lye available. It remains to be seen how far this materializes.

It is evident from the foregoing figures of consumption and possibilities in India that unless new industries develop in which glycerine can be used we shall not be able to keep the glycerine manufacture alive. Glyptal resins open one avenue. These plastics are prepared from glycerine and dibasic acids like phthallic and succinic acids. These give polymerized, light-coloured products whose colour is not sensitive to light. They can be incorporated with acids of linseed oil and thus desirable properties are conferred upon the film. The only disadvantage is that they are not so water-resistant as the phenol resins; but researches which are going on in this line in other countries go to show that in the near future this defect is bound to be remedied.

Numerous experiments by the author have been done to prepare the dibasic acid compounds of glycerol as also to prepare formalin from the latter. It is hoped that all industrial chemists should put forth their energies in solving this national problem of ours.

Research Notes

Chemical Nature of Antipernicious Anemia Principle of Liver

Dakin and West previously described a product isolated from liver extract which was found to be effective in causing blood regeneration in pernicious anemia. From commercial liver extract inactive material is removed by precipitation with alcoholic calcium acetate followed by precipitation of the active material with Reinecke acid. By decomposition of the Reineckate the clinically potent material is regenerated. Subsequent purification was effected by salting out the active material with ammonium sulphate and later by the use of either magnesium sulphate, sodium chloride, or of flavianic acid.

30 mg. of the product caused a perceptible reticulocyte response in suitable pernicious anemia patients, while 80 mg. have given a maximal response. The clinical activity of the product is readily abolished by exposure to cold 0·5N NaOH and by boiling 1 hour with 0·5N, H_2SO_4 and also by salts of heavy metals. No claim to strict chemical individuality was advanced for the active substance.

Dakin, Ungley, and West (*J. Biol. Chem.* *115*, 771, 1936) now describe a method by which they have effected further purification of the active material, thereby obtaining preparations surpassing in clinical activity those previously described.

Ultrafiltration experiments with graded membranes indicate a molecular size of about 2·1 *mμ*, and a molecular weight greater than 2000 and less than 5000.

H. N. B.

Cosmic Radiation

The problem of determining the nature of cosmic radiations continues to retain its own interest. At one time Millikan thought that they were very short gamma rays which are produced in space as a result of combinations taking place between protons leading to the formation of heavier nuclei of atoms. In his own characteristic style he regarded cosmic rays as evidence of the fact that the Creator was still at his workshop in space.

This interesting speculation has however been proved to be incorrect, for a large number workers, Bothe and Kohlhörster in Germany, Clay and Holland and Compton in America, showed that cosmic rays mostly consisted of positrons and electrons having energies ranging from a few hundred million to 10 billion electron volts. Prof. Compton deduced from the analysis of absorption curves that there was a evidence of two types of heavy particles amongst the cosmic rays. One of these, which is found in the sea-level, is probably to be identified with protons, the other, found at greater heights, is probably identical with α rays. Many attempts have been made to detect these heavy particles in Wilson's chamber, but so far without success. In the October number of *Physical Review*, Brode, Macpherson, and Starr working in the University of California, Berkeley, however report that they are able to detect heavy particles in a specially designed Wilson chamber. They consider that about 1 p. c. of the sea-level cosmic rays are probably protons.

The heavy particles which are identified with protons have also been observed by Anderson and Ledermeyer at a height of 4300 meters on Pikespeak, California. They, however, consider that these heavy particles which form about 1 p. c. of cosmic rays are produced by the interruption of primary cosmic rays of nuclei of other atoms.

Extension of the Solar System

H. W. Babcock reports that by using a new Eastman plate hypersensitized with ammonia he was able to photograph the spectrum of the sun up to 13,500 Å units. Most of the strong lines near the infra-red limit are due to water vapour but a prominent feature is the second member of the Paschen series of hydrogen λ 12818, near the other end of the plate (*Publications* of the Astronomical Society of the Pacific, *48*, 206, 1936).

Solar Cinematograph

Students of solar astronomy are aware of sunspots, prominences, faculae, and other phenomena which are constantly appearing on the disc of the sun. The spots can be seen on the image of the sun in a small telescope, but prominences are used masses of gas which are sometimes projected with enormous velocities of the order of 4 to 5 hundred kilometres. They undergo constant change of form and shape. They can be seen only with special devices. But a continuous observation of the changes of form have been so long hampered by lack of suitable instruments. Recently M. Lyot in Paris and Dr Curtis in America have invented cinematographs which show vividly the development of prominences in all its stages. Lyot has also invented a method of photographing the spectrum of the sun in broad daylight—an achievement which was supposed to be impossible a few years ago. (*Bulletin* de la Societè Astronomique de France, May 1936).

Date of Zoroaster

There has been so far great, and rather interminable, controversy about the date of Zoroaster (Zarathustra), the founder of Zoroastrianism. All dates between 6000 B. C. and 500 B. C. have been suggested. Recently R. G. Kent, writing in the *Journal of the American Oriental Society*, (June, 1936, p. 214) has cited the opinion of J. A. Wilson, Director of the Oriental Institute at Chicago, that new archaeological discoveries in Iran have brought the problem nearer solution. The new light comes from an inscription of Xerxes I, discovered by Hertzfeld in his excavation of the ruins of Persepolis. The passage in question runs as follows :

"Sayeth Xerxes the king : When I became king, there were among those lands, which are written above some who rebelled ; then Ahuramazda helped me ; by Ahuramazda's will, such a land I defeated, and to their place I restored them ; and among those lands were such where, before, the Daivas were worshipped ; then, by Ahuramazda's will, of such temples of the Daivas I sapped the foundations, and I ordained 'the Daivas shall not be worshipped !' Where the Daivas had been worshipped, there I worshipped Ahuramazda together with 'Rtam the exalted'.—And there were other things which were done wrongfully, such I righted. This what I did, I did it all by the will of Ahuramazda. Ahuramazda helped me, until I had performed the work.—Thou who art of an after age, if thou thinkest, 'I wish to be happy in life, and in death I wish to belong to 'Rtam',' abide in those laws which Ahuramazda has established, and worship Ahuramazda together with 'Rtam' the exalted. The man that abides in the laws which Ahuramazda has established and worships Ahuramazda together with 'Rtam' the exalted, that one will be happy in life and will, in death, belong to 'Rtam'.

This passage, Wilson believes, conclusively proves that Xerxes was a staunch Zoroastrian and the intensity of feeling displayed in this passage proves that the Achaemenians were recent converts. The inscriptions of his father Darius also make a similar indication. We know that Darius's predecessors, Cyrus and Cambyses, were not Zoroastrians, and after Arta Xerxes I, there was a partial relapse to Magianism.

From these facts it may be concluded that the Vistaspa who gave shelter to the prophet must be identical with the Vistaspa, the father of Darius, who was living at the time of Darius's accession to the throne (521 B. C.). So Zarathustra must have been living about 550 B. C. This is about 33 years later than the latest date hitherto accepted for Zoroaster's death, *viz.*, 583 B. C.

University and Academy News

Royal Asiatic Society of Bengal

An ordinary monthly meeting of the Royal Asiatic Society of Bengal was held on Monday, the 4th January, 1937, at 5-30 p.m.

The following candidates were balloted for as Ordinary Members :—

Vedantatirtha, Narendra Chandra, M.A., General Editor, 'Calcutta Sanskrit Series', Calcutta,

Ahmad, Shamsuddin, Maulvi, M.A., Assistant Curator, Archæological Section, Indian Museum, Calcutta.

The following papers were read :—

1. S. PRADHAN.—The *alimentary Canal* of Epilachna Indica (*Coccinellidæ Coleoptera*), *with a discussion on the Activities of the Mid-gut Epithelium.*

On a comparative study of the alimentary canals of carnivorous and herbivorous beetles of the family Coccinellidæ (Coleoptera), it was seen that there were a large number of both structural and physiological peculiarities in the case of *Epilachna Indica* which are important from the view-point of digestion among insects in general. The alimentary canal of another species of *Epilachna*, i.e., *E. Corrupta*, has already been described by two American workers, Potts (1927) and Burgess (1932), but their accounts have differed from each other. In this paper the author has presented the results of his investigations on *E. Indica.*

2. A. H. HARLEY.—*Marwan B. Abi Hafsah : a Post-Classical Poet.*

Marwan must be given a prominent place in any study of the post-classical Arabian poets. The famous philologist Ibnu'l-A 'rabi has closed with him the list of poets whose work is authoritative for what is correct in diction and taste. His compositions fall into the category of panegyric or elegy, and several specimens raise him to high eminence by reason of the sincerity combined with their literary quality. He could model himself closely on the classical ode.

The following exhibits were shown and commented upon :—

1. THE GENERAL SECRETARY.—*A new loan collection of Sanskrit Manuscripts.*

The Government of India have agreed to the permanent loan to the Society of a large collection of about 12,000 Sanskrit Manuscripts hitherto preserved in the Archæological Section, Indian Museum, Calcutta.

A condition attached to the loan is that the Society shall prepare a handlist of the manuscripts.

The Council have gratefully accepted the offer, and the Manuscripts are exhibited.

The following communication was made :—

1. JOHAN VAN MANEN.—*A difficult Verse in the Dhammapadam.*

The Dhammapada, though translated a dozen times by various scholars, still offers many a problem of exegesis. Intensive treatment of several verses is called for. An example in point is offered by verse 34 in the chapter on 'Thought' or 'Mind'.

In Max Müller's translation the verse runs :—

'As a fish taken from his watery home and thrown on the dry ground, our thought trembles all over in order to escape the dominion of Mara (the tempter).'

The short chapter consists of 11 verses mostly exhorting the reader 'to make straight his trembling and unsteady thought, which is difficult to guard, difficult to hold back'.

How then should thought 'tremble all over in order to escape the dominion of Mara', if it should be steady to achieve spiritual results ? Besides, the fish dies when on the dry land, the water is its home. Has the mind, or the thought, to die in order to escape the dominion of Mara, like the Christian exhortation 'whoever loses his life shall find it ?'

Neumann gives a different explanation. He takes the water as a symbol of the world of desire or death. Whilst living in this world of desire, the world of Mara, the uninstructed soul trembles in fear at the prospect of death.

The main problems posed by the verse are :—

1. May there be a corruption in the text ? If so, what may be suggested ?
2. Does pahātave indicate 'to escape from' or 'to give up, to relinquish' ?
3. Does Mara here stands for 'Tempter' or 'Death' ?
4. Is Maradheyya 'the dominion of Mara' or rather 'the realm of death', or perhaps 'pertaining to the realm of death', like in 'mortal mind'?
5. What is the thought if the verbal form needs an 'in order to' ?
6. Does 'trembling' or 'wriggling' give a better sense ?

In accordance with Rule 44, the following list of gentlemen recommended by Council for election as the Society's Office Bearers for the year 1937, is circulated. The election will take place at the Annual Meeting in February.

President

H. E. The Rt. Hon'ble Sir John Anderson.

Vice-Presidents

Rai Sir Upendra Nath Brahmachari Bahadur.
Dr A. M. Heron.
Percy Brown, Esq.
Lt.-Col. N. Barwell.

Secretary and Treasurer

General Secretary :—Johan van Manen, Esq.
Treasurer :—Dr S. L. Hora.
Philological Secretary :—Dr S. K. Chatterji
Joint Philological Secretary :—Shamsu'l 'Ulama Mawlawi M. Hidayat Hosain, Khan Bahadur.
Natural History Secretaries { Biology :—Dr Baini Prashad.
Physical Science :—Dr J. N. Mukherjee.
Anthropological Secretary :—Rai Bahadur Ramaprasad Chanda.
Medical Secretary :—Lt.-Col. R. N. Chopra.
Library Secretary :—M. Mahfuz-ul Haq, Esq.

Other Members of Council

C. C. Calder, Esq.
N. G. Majumdar, Esq.
K. C. Mahindra, Esq.
*The Hon'ble Mr. Justice Sir John Lort Williams.
*B. S. Guha, Esq.
*W. D. West, Esq.

The National Academy of Sciences, India

An ordinary monthly meeting of the National Academy of Sciences, India, was held in the Physics Lecture Theatre, Muir College Buildings, Allahabad, on Monday, December 21, 1936, with Prof. N. R. Dhar, President of the National Academy of Sciences, India, in the chair.

The following papers were read and discussed :-

1. R. N. Ghosh—On a simple Derivation of Stresses in a moving Fluid.
2. L. S. Mathur—Infra-red Absorption Spectrum of Tin-di-iodide.
3. L. S. Mathur—Determination of Latent heats of Vapourization of the selenides of Cadmium and Mercury and Telluride of Zinc from the absorption spectra of their vapours.
4. B. N. Singh—The Prevention of Rots in Tomatoes with especial reference to the Mould's attack.

Calcutta Mathematical Society

An ordinary meeting of the Calcutta Mathematical Society was held in the Society's room, on Sunday, the 20th December, 1936, at 4-30 p. m.

The following papers were read :—

(*a*) N. N. Ghosh :—A note on the solution of a system of linear equations.
(*b*) S. Ghosh :—On some two-dimensional problems of Elasticity.
(*c*) M. de Duffahel :—Sur certains systemes d'Equations dux Differences totales.
(*d*) M. de Duffahel :—Sur la generalisation du probleme de Dirichlet et sa solubilite.

***N.B.*—The names marked with an asterisk indicate new names proposed for the year 1937.**

Letters to the Editor

Condensation of Succinic Anhydride with Phenolic Ethers

In continuation of the previous work described in a note (*J. I. C. Soc.* 1935.) the study of the condensation of the following phenolic ethers with succinic anhydride has been undertaken with the results described below.

Pyrogallol trimethyl ether condenses with succinic anhydride in presence of aluminium chloride in acetylene tetrachloride medium with the formation of γ-2 hydroxy-3-4 dimethoxy phenyl γ-keto butyric acid m. p. 152°. The substance gives ferric chloride coloration and a methoxyl estimation shows the presence of two methoxyl groups only. Reduction by Clemmensen's method gives γ 2 hydroxy-3-4 dimethoxy phenyl butyric acid m. p. 103°. Dehydration of this substance with concentrated sulphuric acid gives a ring ketone, the semicabazone of which melts at 229°-230° (decomposition). Resorcinol dimethyl ether under similar conditions gives γ-2 hodroxy-4 methoxy phenyl γ-keto butyric acid m. p. 146°-147°. It also gives ferric chloride coloration and a Zeisel estimation confirms the presence of one methoxyl group only.

Ghose Laboratory of
Pure Chemistry
Science College, Calcutta.
30. 12. 36.

Shyamakanta De.

New Type of Magneto-ionic Splitting.

The ionization of the F_2-region has been studied by us for the last several months. In order to determine the critical penetration frequency for any ionized region in the ionosphere it is necessary to increase the frequency of the transmitted pulse gradually till the echo penetrates the region. The apparatus developed by us is such that one single observer can manipulate the transmitted frequency with one hand, and the receiver can be kept tuned by means of the other hand; so that there is a continuous change of frequency and the echo does not disappear from sight throughout..

The electron density and the highest frequency which can be reflected from that region are related as follows :—

$$N = 1{\cdot}28 \times 10^{-8} f_o^2 \qquad (1)$$

where N is the number of electrons per cubic cm. and f_o is the critical penetration frequency for the ordinary ray.

During the day no magneto-ionic splitting of the wave has been seen for the F_2-region, even when the transmitted frequency was very much near the critical penetration frequency. This apparently seems to be due to the greater absorption of the extraordinary ray during the day.

However, working after midnight, when the ionization and absorption in the lower regions become very small, both the ordinary and the extraordinary rays have been seen and the difference between the penetration frequencies of the two rays has always been found to be in the neighbourhood of 0.14 Mc./sec. when the critical penetration frequency was between 3 and 4 megacycles per sec. On rare occasions, however, we have found this to be 0.64 Mc./sec.

The penetration frequency differences calculated for vertical propagation from the three conditions of reflection obtained by putting $\mu=0$ in the Appleton-Hartree dispersion equation can explain only the second experimental value of 0.64 Mc./sec. But the first value of 0.14 Mc./sec. could not be accounted for by the existing theory, and for a time the problem was very perplexing. However, recently Mr R. N. Rai has examined the problem from a fresh point of view. He has assumed that reflection is obtained only when the group velocity becomes zero. The results obtained by him show that in addition to the usual results, for short waves one more condition for reflection of the extraordinary wave is obtained, *viz.*

$$p_0^2 = p_1^2 - p_T^2 \quad \text{(approximately)} \qquad (2)$$

where $p_0^2 = \frac{4\pi Ne^2}{m}$, p_1 is the critical angular frequency for the extraordinary ray and $p_T = \frac{eH_T}{mc}$, and H_T is the value of the horizontal component of the earth's field. The condition for reflection of the ordinary wave is

$$p_2^2 = p_0^2 \qquad (3)$$

where p_2 is the critical angular frequency for the ordinary ray. Thus from (2) and (3)

$$p_1^2 - p_2^2 = p_T^2$$

whence, the difference between the critical frequencies when p_2 is 4·0 Mc./sec. comes out to be 0·14 Mc./sec which agrees very well with our experimental results.

The full paper of Mr Rai will appear in the *proceedings* of the National Institute of Sciences and the full details of our experimental results are being separately published.

Department of Physics
University of Allahabad.
24.12.36.

B. D. Pant.
R. R. Bajpai.

LETTERS TO THE EDITOR

A note on the Digestive Enzymes of *Paratelphusa (Oziotelphusa) Hydrodromus*, (Herbst).

The digestive secretion of ***Paratelphusa*** in addition to its action on starch, glycogen, sucrose, maltose and lactose acts also on hemicelluloses showing the presence of a cytase. Among decapods a cytase has been recorded only in ***Astocus*** by Biederman and Moritz[1]. Enzymes hydrolizing amygdalin, arbutin, coniferin and salicin are present. The secretion has no action on phloridzin as in the case of ***Portunus, Maja,*** and ***Platycarcinus*** investigated by Giaja[2].

The amylolytic enzyme acts best in neutral medium and has its optimum temperature at 45°C and its temperature of destruction at 62°C. A comparison of these results with those obtained by Yonge[3] in the case of ***Nephrops*** is interesting. ***Nephrops*** lives under colder conditions and yet its amylolytic enzyme has its optimum temperature at 57°C and its temperature of destruction at 78°C.

Our findings agree with those of Yonge[3] in that there is only a "tryptic" proteolytic enzyme. We were unable to detect any trace of a "peptic" type contrary to the findings of Krukenberg[4]. This proteolytic enzyme acts best in an alkaline medium and has its optimum in a medium of N/20 Na_2CO_3, as in the case of ***Nephrops*** and ***Carcinus*** investigated by Yonge[3] and Roaf[5] respectively.

The lipolytic enzyme exhibits the usual reactions, hydrolizing a large number of esters and emulsions of olive oil.

Department of Zoology, A. R. Reddy.
Annamalai University. K. V. Reddy.
4. 1. 37.

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A Study in the Relation of Memory and Observation in Feeble-minded Children

Obtaining an opportunity to examine four feeble-minded boys I tried to find out if memory bore any correlation with accuracy of observation in their case. A few years back I tested a number of normal adults and found a positive correlation of moderate value between their memory and observation. (The result of that investigation was reported to the Indian Science Congress).

In the present series of experiments I have tested four distinctly feeble-minded boys, A, P, R, and S, of ages 11, 15·0, 11, and 14·5 years respectively. Of these A is a Panjabi, P a European and R & S Bengalees. All of them come from apparently normal, well-to-do parents of good middle class. A and P were examined only twice at interval of 48 ours. R and S were examined for six consecutive days and once again after a month and a half, during which period they were given *sense training*. The I. Q. was determined in each case with the Stanford Revision Scale and its Hindi and Bengali translations.

Memory of these groups of boys was tested with senseless and meaningful syllables by the 'learning process'. Accuracy of observation was tested by exposing for about 4 seconds carefully selected picture cards containing four to six clearly distinguishable items forming a definite, not-too-unfamiliar, pattern. The time of presentation was regulated with Bose's electro-magnet controlled exposure apparatus. Correlation between the mean values of the score for memory and that for observation was calculated by the Pearson's Product Method. A tachistoscopic experiment was performed to determine the range of attention. For a comparative study two normal boys of ages 10 and 13 were similarly examined.

All these experiments and examinations were carried out in the laboratory of Psychology with kind permission of Dr. G. S. Bose, head of the department.

	Feeble-minded				Normal	
Subject	A	P	R	S	M	T
I. Q.	48	46	55	60	82	88
Correlation	+·2	+·2	—·15	+·3	+·6	+·65
Attention	22%	21·3%	22·2%	22·3%	32·6%	30·4%

Results: (1) There seems to be little correlation between memory and observation in case of feeble-minded boys. In case of normal boys there is a small positive correlation.

(2) For feeble-minded boys, memory scores for senseless and meaningful materials are practically the same.

(3) Relatively speaking, for the feeble-minded boys the power of observation is much less than that for memorization. The normal group shows an average improvement of 16% in case of memory and 40% in case of observation, over the other group.

(4) Practice effect (in case of R and S) produced an all-round improvement of about 6% only.

(5) The range of attention is almost identical for members of each group.

Remarks: The data are too inadequate to draw any general conclusion. The suggestion may be hazarded here that memory and observation are both functions of attitude and since the morones take little interest in their surroundings or have less developed conative phase of response, their scores for memory and observation are low. And since accuracy of observation demands more of active interest or conation than memory would, the score in case of the former is proportionately less. Attention may not play so important a part as it is supposed by some to do.

Psychology Laboratory,
Calcutta University.
29.12.36

S. K. Bose.

Formic Acid as a Solvent of Lignin

Very recently Staudinger and Dreher[1] have extracted lignin from pine wood with 92% formic acid at about 100° in an atmosphere of nitrogen. By four repeated extractions, extending over 156 hours, only about 50% of the lignin could be dissolved out. The product appeared to be more or less homogeneous as regards methoxyl value and C, H-content. By the cryoscopic method in dioxan the mol. wt. of the lignin was found to be about 1000.

This low figure for the mol. wt. of lignin from pine wood appeared to be highly interesting in view of the fact that other inavestigators including Freudenberg and co-workers[2] and Klason[3] obtained much higher values. In a series of papers published in the *Journal* of the Indian Chemical Society (1932-35) the author has shown that the mol. wt. of jute-lignin is 830 or a figure very near to it. It was therefore thought worth while to see if a similar figure could be obtained for jute-lignin without using highly concentrated mineral acids for its isolation.

Following mainly the procedure of Staudinger and Dreher a sample of lignin has been obtained from purified jute, which has quite different properties from that by 42% HCl at low temperature. It is deep brown, while the HCl-lignin has a light rosy colour. Unlike HCl-lignin, which is insoluble in all media, it is highly soluble in acetone, glacial acetic acid, and caustic alkalis, and partly soluble in chloroform, ethyl and methyl alcohol. It reduces Fehling's solution very readily while the former does not. The iodoform-yielding complex however is present in it as in HCl-lignin. As in the case of pine wood, only a part of the total lignin could be extracted even by repeating the operation several times.

Quantitative filter paper was treated with formic acid under identical conditions. A light brown extract was obtained, which, when poured in a large volume of water, gave a precipitate. This reduces Fehling's solution, as also the residue left after complete evaporation of the formic acid from the filtrate. Thus, the method is not free from the objections raised by Hilpert and Littmann[4] to the use of mineral acids for the isolation of lignin.

A complete analysis of the lignin obtained from jute by the formic acid method is in progress.

My grateful thanks are due to my steemed colleague, Prof D. C. Roy, M. Sc., for affording me all facilities for work.

Chemical Laboratory,
Vidyasagar College,
Calcutta.
16. 1. 36

Pulin Behari Sarkar.

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Psychoanalytic Treatment

On page 260 of the last November issue of your esteemed journal you have referred to a note in the *Scientific American* regarding psychoanalytic treatment emanating from Dr Hyman. As I am afraid that the extract is likely to produce an unfavourable, not to say unfair, impression in the minds of your readers about the efficacy of psychoanalysis, I take the liberty of sending you the following lines with the request that you will be kind enough to publish them in the next issue of your journal.

1. Psychoanalysts are not so much devoid of commonsense as to claim that "if properly treated all cases of mental diseases can be cured with its aid."

LETTERS TO THE EDITOR

2. It is really a wonder that a physician of Dr Hyman's eminence has never heard of such an important event in the history of psychoanalysis as the discovery of the methods and techniques of child analysis. If he did, he would certainly not have made those remarks about the age of the patients that he has unfortunately done. Except the congenitally feeble-minded and those in whom senile decay has definitely set in, psychoanalysis can be and has been applied with good results. A look at Melanie Klein's authoritative book on the subject and a visit to a neighbouring child clinic by Dr Hyman would certainly make him change his mind regarding the age of the analytic patients.

3. I am in full agreement with Dr Hyman when he says that psychoanalysis is a very costly method of treatment. Psychoanalysis undoubtedly requires much time, patience, and money for effecting a successful cure. In India the cost would certainly be much less and possibly not more than what the average man has to pay nowadays to the doctors and the various chemical examiners for the treatment of physical illness, if it is just a little complicated. That the poor man cannot afford to pay for the uptodate method of treatment of physical maladies is certainly a fact but it is certainly not an argument against the utility of the modern therapeutic procedure. Similar is the case with psychoanalysis.

4. Reference to a statistics of 43 cases for the support of an argument, when more elaborate and authentic statistics are obtainable, is much like giving the dog a bad name in order to hang it. A perusal of the reports of the British, Berlin, Vienna, Chicago, and other psychoanalytic institutes and occasional references to the journals published under the auspices of the International Psychoanalytical Association will provide Dr Hyman with much fuller statistics than he has been able to collect.

The reader of the abstract published in your journal will never realize the immense services that have been rendered by psychoanalysis to society by drawing attention to the mode of development of the child mind and thus to the necessity of reforming the current ideas about the proper method of education. Prevention is always better than cure and psychoanalysis has shown us the way which, if followed, is bound to lessen the chance of the onset of mental diseases.

May I point out to you, Mr Editor, in conclusion that erroneous, imperfect, and sometimes definitely mischievous views regarding psychoanalysis are very common and that they are likely to produce more immediate evil effects upon the individual and the society than an erroneous view about physical universe. It is the duty of everyone concerned to combat such views and I sincerely hope that you will fully co-operate with the members of the Indian Psychoanalytical Society in the task of spreading correct views about psychoanalysis, especially in our country.

Psychology Department, S. C. Mitra.
Calcutta University.
7.1.37

[Our readers are very well aware that we have always regarded psychoanalysis as an important branch of science. As in certain quarters, psychoanalysis is unfortunately regarded with some partisan spirit, we thought that it might interest our readers to know what a non-psychoanalyst had to say about the efficiency of this method of treatment. We are sure that Dr Hyman, whose original paper was published in the *Journal of the American Medical Association*, had no intention of showing psychoanalysis in an unfavourable light in writing his paper. Neither had we. We are however glad to publish Dr Mitra's letter in case our note had inadvertently any such effect. —*Editor*, SCIENCE & CULTURE]

SUPPLEMENT—Abstracts of the Sectional Presidential Addresses of the Indian Science Congress, 1937

Physics and Mathematics

On absorption of light by atoms and molecules

—Dr S. Datta

Dr Datta gave a general sketch of the main facts relating to absorption of light by atoms and molecules and of the various theories which have been formulated to explain them.

The address was divided into two sections. In the first part dealing with absorption by atoms, he began by relating that the most significant feature of absorption is that, out of the various series in which the emission spectrum of an element can be classified, those belonging to one series only come out in absorption. This has been explained by the simple Bohr theory coupled with the selection rule for inter-orbital transitions and the Boltzmann distribution of atoms in the various states. The absorption of some lines contrary to the selection principle first secured by him led to a modification of the selection rule and has been explained as due to atoms having quadrupole moment as well. Relating to the appearance of higher series lines by excited atoms he cited experiments which showed that an increase in the concentration of atoms in the excited state brought about by thermal, electrical or optical stimulus is responsible for the appearance of these lines. The absorption experiments thus lead to two generalized statements.

(1) The line absorption phenomenon is entirely dependent on the concentration of atoms in energy states which are possible under the experimental circumstances; and

(2) It manifests a *complete* and *not a part absorption* of the energy of the photon with which the atom collides, provided that this energy is exactly equal to the amount required for the transition of the atom to higher states which are permissible under the selection rules.

Dealing next with the question, what happens to the radiation when it is absorbed, he showed how the various experimental facts lead to a generalization that the absorbed photon loses its identity as an indivisible packet of energy and forms a part of the total energy of the excited atom, which is liable to dissipation according to the circumstances of its situation. It may thus give rise to the familiar phenomenon of Resonance and Fluorescence or to various others that may be expected on theoretical considerations by 'collisions of the second kind.'

Passing on to the question of the intensity of absorption lines he showed how the ordinary quantum theory is inadequate to explain the facts of observation and how a more satisfactory solution is obtainable from the recent theory of radiation proposed by Dirac.

Talking of the width of absorption lines, he discussed the modern theory both of natural as well as pressure broadening. Natural broadening is now explained as a small variation in the energy value of each level, which can be calculated from the life-period of the atom in a given state by applying Heisenberg's principle of indeterminacy. While pressure broadening is accounted for as due to a conversion into light energy, the energy of irregular motion of quasi-molecules formed by forces of the Van-der-Waal type.

With regard to the phenomenon of continuous absorption by atoms of frequencies lying beyond the limit of the ground series of lines which indicate a process of photo-ionization of atoms, he drew attention to the existence of two maxima of absorption, only one of which can be explained.

In concluding this part, he discussed the question of applicability of the laws of conservation in processes of exchange of energy between photon and matter and showed that a division of the energy of the photon which follows from the laws of conservation is irreconcilable with the phenomenon of discrete absorption, which demands that the photon energy should be indivisible. A mechanism by which Compton effect could be explained without dividing the quanta has been suggested but difficulties still remain with Raman effect.

In the second part dealing with absorption by molecules he related how the infra-red radiations can be absorbed only by molecules having a dipole moment, *i. e.*, by ionic or polar atomic molecules whereas the light of greater energy can be absorbed by both atomic or ionic molecules.

Talking of the main features of absorption by various types of molecules, he stated that the occurrence of more than one continuous absorption maximum may as a rule be taken as the chief criterion of an ionic molecule particularly composed of singly ionized atoms, whereas banded absorptions are due to atomic molecules, polar and non-polar. Banded absorption is however possible, though not actually on record, with ionic molecules composed of doubly ionized atoms. Atomic molecules may however show continuous absorption unaccompanied with bands, particularly when the ground state is formed by a spin coupling of two neutral atoms and the excited repulsive state is due to a reversal of the spin vector of one of the atoms, as is presumably the case with the hydrogen halides. Polarization molecules generally show a short continuous absorption in close proximity with the atomic resonance lines. At high pressure the continuous band may develop a structure as has been observed by him in the case of potassium.

With regard to banded absorption, accounts have also been given how the intensity distribution is explained on Condon's theory and how from the classifications of the different progressions it is possible to calculate the heat of dissociation of molecules.

Relating to studies of continuous absorption, the use of micro-photometer has been strongly recommended and suggestion has been given about the best method of preparing the spectrogram for micro-photometric analysis.

The question of determination of fundamental vibration frequency from continuous absorption records has next been discussed in the light of author's own observations relating to HCl, HBr, and N_2O, which seemed to justify the procedure.

After dealing with the phenomenon of predissociation and Saha's theory of dissociation of poly-atomic molecules by absorption of light and of the colours of inorganic salts, Datta has concluded his interesting survey by indicating the important role played by absorption experiments in the discovery of rare isotopes of oxygen and nitrogen and the various applications of the method to industrial and medical problems.

Chemistry

The Chemistry of Antimalarials

—Dr J. N. Ray

Malaria is the greatest obstacle to the progress of India. Apart from the terrible toll it takes annually in the form of human life, its influence on labour inefficiency is a serious factor in the industrial development of the country. The physical, intellectual and economic deterioration of this subcontinent can be attributed mainly to this one cause. For this reason no subject can be of greater interest to us than an account of the recent development in the prevention and cure of malaria by chemicals.

The investigation of the nature and properties of a drug begins with the isolation of the active principle to which its physiological action is due. This is followed by a determination of its structure by analytical and synthetic means and after its molecular arrangement has been unravelled, a study of the related derivatives makes it possible to locate the seat of pharmacological action. As an illustration the case of quinine affords a most striking example.

The pharmacological action of quinine may be located in (*a*) the quinoline ring, (*b*) the quinuclidine part, or (*c*) in vinyl grouping.

The examination of various derivatives proves that it is essentially in the quinoline part of the molecule. Various quinoline derivatives have been synthesized of late of which the substance plasmoquin and the Russian product plasmocide have been found to be valuable. Plasmoquin is not bitter and has definite antimalarial action.

It is not claimed that plasmoquin is a substitute for quinine but that it can be used with quinine owing to its more toxic action on gametocytes. The quinine-plasmoquin treatment has been tried or a large scale by the Bengal Government and it appears that it is definitely beneficial, but whether plasmoquin alone is a reliable prophylatic against the transmission of malaria has still to be definitely proved.

Mietsch and Mauss have prepared substituted alkylaminoacridine derivative of which the substance called "atebrin" has been found to be a valuable antimalarial.

In his experiments with birds infected with *plasmodium praecox*, Kikuth found it to be less toxic than plasmoquin, from which it differs in that it does not affect the gametes but kills the schizont forms. Thus it is complementary to plasmoquin. Atebrin acts directly on the trophozoites of all three types of the parasites but has no action on the crescents of the subtertian type.

A drug having true prophylatic effect must possess a specific action on the sporozites. Neither plasmoquin nor atebrin, however, possesses this action. A drug has yet to be discovered which will have curative value in subtertian infection. In recent years a large amount of work has been done in seeking an ideal antimalarial. Although the experiments have not yielded positive results, still some purpose has been served in that certain apparently reasonable postulates have been investigated and eliminated.

The work of Mrs Robinson, Robinson, Narang, Ray and Singh, Aggarwal, Qureshi and Ray, Brahmachari and Das Gupta, Chatterji, Sheshadri, Kermack, and Clemo have all been helpful in this respect.

Opium was reputed to possess prophylatic value in malaria. This possibility has been investigated at Lahore but it seems doubtful if any effective antimalarial can be found amongst the derivatives of opium alkaloids.

Simonsen deplored in 1928 that very little work has been done in India on natural product. Since then there has been an improvement and at Delhi, Calcutta, Lahore, and other centres useful work is being done.

The financing of research is a problem which requires early solution. There is a distinct tendency for the public to ignore the universities in their charity. There are exceptions of course as evidenced by the princely gifts the Calcutta University received from the late Sir T. N. Palit and Sir R. B. Ghose. Recently Sir P. C. Ray, 'the father of Indian chemists' has also made a commendable donation. Let us hope his words in this connection would inspire the industrialists of our country to emulate his noble example. The life-long service rendered by Sir P. C. Ray to the cause of chemistry is unique and this country is blessed to have a man of his stamp. Any one who helps the cause of research work would be doing a national service, for chemistry is the key science both in peace and war and "chemical research is synonymous with national welfare" as Emil Fischer truly remarked some years ago.

Geology and Geography

Earthquakes in India

—W. D. West Esq.

The foundations of the scientific study of earthquakes in India were laid by Dr T. Oldham and his son R.D. Oldham. The latter will best be remembered for his great memoir on the Assam earthquake of 1897, and for his discovery of the three main types of earthquake waves that are recorded on the seismograph, a discovery that has proved most fruitful in investigations regarding the internal structure of the earth.

The occurrence of earthquakes in India is a legacy of the great earth movements that convulsed the northern flanks of India during Tertiary and Quaternary times, throwing up the Himalayas and the Baluchistan and Burmese mountains. For this reason earthquakes are confined in their distribution to these mountain ranges and to the plains immediately bordering them. By comparison Peninsular India is an area of comparative safety, in which only minor shocks occur.

A detailed analysis of the geological structure of the earthquake belt provides an explanation of the origin of most of the earthquakes occurring within it. In Cutch the subsidence of the coastal tracts beneath the sea is probably the cause of earthquakes in this area. In Baluchistan the re-entrant angle in the alignment of the hills by Quetta and Sibi must be an area of special strain, and earthquakes are concentrated around it. In northern India earthquakes probably originate in movement along one of the many thrust faults that have developed as a result of the southward advance of the Himalayan range. In Assam the Assam range, a fragment of Peninsular India, is caught between the converging earth waves from the north and from the east, and has become rent by fault fractures, which are the cause of the earthquakes. Finally, in Burma most earthquakes have been located on one or other side of the central Tertiary belt, a sunken trough or synclinorium bounded by zones of faulting on either side.

During the present century earthquakes have been confined in the main to three centres of activity—Baluchistan, Assam, and Burma—with an occasional disastrous earthquake elsewhere within the danger zone. The Assam earthquake of 1897 was probably the most severe that has occurred anywhere within historic times, though the loss of life was small. But the Kangra earthquake of 1905, the north Bihar earthquake of 1934, and the Quetta earthquake of 1935 between them accounted for at least 60,000 lives.

This disease of earthquakes is a chronic one, but is not peculiar to India. Other countries that suffer from it, such as Japan, California, New Zealand, and Italy, have taken steps to combat it, but in India practically nothing has so far been done. It is strongly recommended that a seismological branch of one of the existing services be started, and that research be conducted similar to that done in Japan. The cost of such a branch would be trivial in comparison to the many crores of rupees worth of damage done by a big earthquake. In addition endeavours should be made to improve the standard of building within the earthquake belt. The value of simple earthquake-proof construction in saving both life and property was clearly demonstrated during the Quetta earthquake. A simple building code should be drawn up by which new construction and town planning in the more important cities of India could be controlled. In addition, more detailed codes should be drawn up in accordance with local needs, and enforced by Provincial Governments and Local Boards.

Botany

The need for scientific study of India's climax vegetation

—H. G. Champion Esq.

Forest growth still covers about one quarter of the land surface of India, and if it were not for human settlements and forest destroying activities, it would undoubtedly cover the whole country with the exception of the excessively dry north-east portions, a few dry tracts in other parts, and the relatively limited alpine areas in the Himalayas which are too high, cold, and exposed for it.

It might accordingly be expected that, trees both individually and collectively, would form the subject of much botanical study in this country which has seen the oldest civilization in the tropics and is still much the most highly developed tropical country. Even in temperate western countries, very little is yet known about the physiology of the individual tree and still less of the physiology of tree crops, and the life-history and problems of the tropical forest are still almost unexplored. In the absence of the needed information, there is a rather dangerous tendency to apply what is known or believed to hold for the temperate forest without proof that such application is permissible.

The interesting problem of the method by which water is lifted to the top of even the tallest trees is almost the only one which has so far attracted much attention. Studies of light quality and intensity under different types of tree canopy and the reactions of the ground vegetation and the regeneration of the overwood trees to variations in these factors are much needed. The absolute water requirements of tree crops in relation to the demands of other types of soil cover are of importance in all irrigated and dry tracts, and call for investigation. Further, wide fields for study are offered by problems connected with the secretion of resins, dammars, gums, and oils: also those connected with genetical and distribution problems. Only small beginnings have been made of the study of the tropical forest in relation to the soil, though the great importance of a forest cover especially in the tropics is now generally realized. In its role of the great contributor of humus to the soil, it is of the deepest significance to the agriculturist and indeed all humanity, but we still have extremely little precise information on the subject. This reaction of forest on soil is reflected in the succession of forest types which follow one another on new soils which have been and are being laid down by river action and in other ways, providing a most interesting and important field for ecological studies. The professional forester is well aware of the occurrence of such successions but the trained research worker is required to study them in full scientific detail.

The consequences of the maltreatment and gradual opening out or destruction of the forest cover provide the reverse aspect of ecological succession towards the climax vegetation. Such retrogression in many parts of India has gone far beyond mere botanical interest to become an economic problem of first-rank importance. Realization is now rapidly spreading of the causal connection between denudation of forest cover in the hilly tracts and the loss of fertile soil on the slopes by erosion, the overwhelming of valuable agricultural land at the foot of the hills by sand, gravel, and boulders brought down by torrents themselves generated by the loss of the absorbent forest and soil cover, and also the occurrence of disastrous flood in the plain.

The scientific study of trees and crops calls for a special technique, both in the collection and the analysis of data. This is mainly due to the large size of the individual and the space it occupies, and the slowness of its development to maturity and subsequent decay, but complications also ensue from exposure to all kinds of influence, mostly injurious ones from which agricultural crops are more or less protected.

India is in a unique and very favourable position to lead the world in the study of the tropical forest, the problems awaiting solution being full of interest to the scientific worker, and full of importance on their economic side.

Zoology

Helminthological research in India

—Dr G. S. Thapar

Dr. G. S. Thapar, in his presidential address on the needs and opportunities of helminthological research in India emphasizes the importance of helminthology in medicine, public health, veterinary science, and agriculture. He pointed out the indifference with which this science was studied in India, but in recent years there seems to be a growing appreciation, both by the Government and the universities, of its importance. The recognition of the work of professional zoologists in India seems to be a healthy sign, as the past records in this connection in other countries reveal the solution of many fundamental problems of helminthology at the hands of the zoologists.

It is true that refinements in sanitation are helpful in the eradication of human parasites: in fact, "*Taenia solium* is said to have taken a road to extinction when the mythical Chinaman burned down his house, ate the incinerated pig and pronounced that it was good." But there are a great many difficulties in the control of helminths of domestic animals. Limited sanitation, over-population of farm animals, due to greater utilization of land for agriculture and human habitation, varied means of transportation and climatic factors—all help to increase helminthic infections of the domestic animals. It is, therefore, necessary that investigations should be undertaken on an extensive scale on these problems in an agricultural country like India.

Referring to the ancient history of the subject in India, Dr Thapar drew attention to the references found in Susruta, Charaka and Madhava Nidhana and from these he has identified such worms as *Dvimukha* and *Parisarpa* as *Enterobius vermicularis* and *Microfilariae* respectively under the modern scheme of nomenclature. But very little progress seems to have been made on the subject in ancient India and the doctrine of *ahimsa* seems to have played its part in this direction.

Much of the recent information on worms in India is due, chiefly, to the valuable work of certain enthusiastic officers of medical and veterinary services, who, in the course of their routine work, were confronted with worms and this formed the basis of our present knowledge of the subject.

Unfortunately, there are great difficulties in providing adequate knowledge of helminthology to our students in India, as though the textbooks in zoology claim to have been revised and brought up to date, they still contain old and antiquated nomenclature and classification and these instances are enumerated. Some of these textbooks give a confused account of the life histories of even the common worms, like *Ascaris*. This leads to a serious handicap in the treatment and application of preventive measures.

Further, is is desirable to avoid imparting an anthropomorphic outlook of helminthology to the students of zoology, as in this the students generally lose all interest in the subject for the rest of their career. A student should study the subject to explain the phenomenon of parasitism and for this he should collect helminths from his own dissection animals.

In suggesting the scope of work, Dr Thapar says that there is considerable field for investigation in the morphology of the worms as helminth fauna of India still remains unexplored. Even the re-investigation of the described forms seems to offer ample scope of work, as errors in diagnosis are perpetuated in the recent literature on the subject. Illustrations are given from the works of previous authors to show the justification of re-investigation of even the described forms. The chief problem in helminth morphology to-day is the elimination of errors which unfortunately have crept into the earlier literature.

The accurate morphology and natural classification would answer the problems of relationship and evolution of the group and numerous illustrations cited have been collected from the work of Dr Thapar and his colleagues at Lucknow.

The solution of life-histories will greatly facilitate the control measures and Leiper's work on the Schistosomiasis in Egypt amply justifies further work on similar lines. The recent discovery of *Echinococcus* cysts at Lucknow stimulating *coenurus* cysts seems interesting and promises fresh fields for experimental investigations.

The question of host specificity is also discussed and conflicting observations by prominent workers are indicated to show the necessity of further investigations on the subject. The question does not seem to be a settled one.

Considering the pathogenic effects of helminths, Dr Thapar made references to the recent demonstrations of *Enterobius vermicularis* as a cause of appendicitis in man and this has awakened interest for the study of the diseased condition, more particularly in animals. The discovery of *Schistosoma spindalis* as a cause of nasal granuloma of cattle, commonly known as snoring disease in India and the recent investigations on the etiology of "Barsati" of equines, showing *Habronema larvae* in the affected parts of the animal's body are illustrations to indicate worms as cause of disease in animals. Both these animal diseases were believed to be of mycotic origin and these discoveries mark a new era in the disease investigation of animals in India.

There are a large number of anthelmintics used for the removal of worms but a considerably larger number prescribed by Hakims and Vaids, claim specificity for particular kinds of worms. Chopra has investigated many of these indigenous drugs for their action but a majority of them still need verification. The crude method of administration of certain plant products, like the juices of *Blumia lacera* (kukronda), as local application and otherwise against the common pinworm of man by laymen, offers fresh field in study of drug administration in their natural condition, particularly for the domestic animals. The effects of yeast and vitamins on the immunity problems form a necessary adjunct to such investigations, as it would be desirable to obtain parasite-resisting strains of animal population that would be better fitted in the struggle for existence.

The production of pearls inside the molluscan shells is said to be due to the presence of helminth larvae and for this, growth of such larvae may be encouraged. This is an aspect of helminthology that demonstrates its utility to man.

In view of such opportunities of varied nature offered by the study of helminthology in India, and its growing significance in different spheres, emphasis must be laid on the necessity of co-operation amongst workers in different fields—medical, veterinary, public health, and agriculture—so that we may be better able to combat the problems and obtain most satisfactory results. The experience of such a work in other countries amply justifies such a line of action in India. Let us, therefore, stimulate interest in the study of helminthology so that by patient interest and diligent application we may help in the solution of the various problems connected with helminthological research and thus establish an active school of helminthology in India.

Anthropology

An ethnological study of the Coors

—Dewan Bahadur Dr L. K. A Lyer

Dewan Bahadur Dr. L. K. Ananta Krishna Iyer reviewed the progress of anthropology during the past 24 years in his presidential address. The scope of anthropology, he said, is now very much broader; and physical and cultural anthropology differ widely in their functions. On the physical side zoology looks backwards on palaeontology, while physiology beckons to psychology across the 'no-man's land' represented by psycho-physics. There is again human biology with heredity, environment, and genetics. On the cultural side which covers archaeology, history, and economics, attention must be paid in turn to industries, arts, institutions, beliefs and, not the least of all, language as the key which unlocks the inmost sanctuary of the mind. The problems connected with them form a fascinating branch of ethnology. For the sake of greater precision, it must be said that anthropology ought not to be given a narrow sense of somatology. The physical and cultural sides of the study of man must be dealt with in strict conjunction, however different may be the methods required in each case. Surely the interaction of body and mind is too subtle and all-pervading to permit of any divorce between the material and spiritual aspects of human nature.

The principal subject of his address was an ethnographic study of the Coorgs. The writers who had made an intensive study of the Coorgs differ in their conclusions, and Coorg inscriptions throw very little light on the early history of that interesting community. The province was successively connected with the Kadambas, Ganga Dynasty, Hoysala Kings, Nayaks of Belur under Vijayanagar rulers, the Lingayat Rajas of Coorg as also those of the Bednore family. Further the Coorg Rajas were themselves aliens. Wynad Chetties have their settlements in Coorg as their house names testify. From all these facts it is conjectured that the Coorgs are not without a racial admixture from a remote period. There is also a great deal of cultural contact between the Coorgs and the people of Malabar, Canara and the Tamil districts, and the Tulu population. Their language is a mixture of the Dravidian languages. The physical traits are biologically useful, and related to mental capacity and intellectual endowment. Applying this maxim to the Coorgs, their mountain habitat, climate, food and occupation have largely made them what they are at present. It is interesting to note that these factors have differentiated them from the people of the plains.

Dr Iyer next dealt with the economic life of the Coorgs who were first hunters and fishers, and then agriculturists. Their hunting propensities are still seen in their festivals, and their primitive weapons are being gradually replaced by modern guns and spears. Fishing is generally carried on in streams and paddy fields during the rainy months. Agriculture of the Coorgs which is of the rudest kind is similiar to that which prevails in other parts of India. It is a system of rural economy formed at a remote period and transmitted for ages unchanged. The cultivator is attached to the ancient practices, and views with dislike any attempts at innovation. Industry of the people of the highlands is confined exclusively to the cultivation of rice. The narrow valleys between two high grounds are very productive, the agricultural implements are few and of the rudest kind, and yet the yield has furnished an unfailing supply from ancient times both for consumption and export to Malabar. Where-ever possible, the valleys have been formed into flat terraces for cultivation.

The agricultural year, as in other parts of South India, begins about the middle of April *Chaitra Sankranti*. With the first shower in April or May the ploughing commences. On an auspicious day before sunrise the house lamp, which plays a conspicuous role on all festive occasions, is lighted in the inner verandah when the members of the family assemble and invoke the blessings of their ancestors and Cauvery Ammen (River Deity). The young men make obeisance to their elders, and drive a pair of bullocks to the paddy fields, where they turn the heads of these to the east. The landlord now offers cocoanuts and plantains, rice and milk to the presiding deity of the *nad* (division of the district) lifting up his hands to the rising sun, and invoking his blessing. The oxen are yoked and three furrows are ploughed when the work is finished for the morning. Of the upturned earth he takes a clod to the storehouse or granary and offers his prayers to Siva to grant him an increase of one hundred times. The recognition of the source of material well-being is due to their industry to command success. From 6 to 10 A.M. the ploughing continues till the fields are turned two or three times. Then the borders are trimmed, and the little banks repaired to regulate water. After this, sowing, transplanting, weeding, and finally harvesting are in operation. Before the completion of transplantation of the largest field, an open space of 10 feet wide is left throughout the whole length, to provide the Coorg race-ground offering a jolly good sport amidst their monotonous work.

To a large number of Coorgs, cultivation of coffee, cardamoms, and fruits are important industries. The Coorgs are fond of honey gathering. It is a domestic industry. The Coorgs have an abundant supply of food materials. They rear pigs and goats. Their chief article of diet is rice and on festival it is proverbial. The Coorg houses like those of the Nayars are generally situated close to their paddy fields on a sheltering slope of Bene land surrounded by columns of plantain trees, sago palm, betelnut palms, orange, jack, and guava trees. A coffee and a small kitchen garden are seldom absent. In the compounds of some houses there is a small pond well stocked with fish. The nature of types of building very much resemble those of the Nayars of Malabar and the approaches of the old Coorg house mark the design of fortification. The tradition points back to the time of general feuds when chief fought with chief and clan with clan. Deep kadangas or trenches with high embankments still testify to the memorials of their warlike state of affairs in former times. The furniture of a Coorg house bear ample testimony to the simple habit of the inmates. The Coorgs are a hardy race and bear with fortitude much hardship especially during the monsoon months when they are engaged in cultivation. Exposed to all the inclemencies of the weather they retain their vigour, most admirably. Their dress and ornaments are peculiar. Their marriage regulations are a curious medley of old and new rites, fashions and notions. In former times their marriage festivities had a communal character. Marriage is adult and has some of the formalities of the Hindu ceremonies. The Coorg family is joint and patriarchal. There is not a single family affair of any importance which may not be undertaken without the consent or knowledge of the senior member. The senior female member is the queen of the household. Their public morality is controlled by a council of elders, and they are the moral censors and managers of all social matters without any material help from the Government. The offenders are punished with fine or excommunication. The Coorgs are animists and have their ancestor and demon worship. They have been influenced by the Malayali, Tulu, Canarese and recently by Canarese, Brahmanical, and Lingayat superstitions. The Tulus have smuggled in their demons and ancestors worship, and their services are often requisitioned. They worship Cauvery Ammen, and their chief festivals are Huttari corresponding to the onam festival of Malabar and Kaylmurta. Of late they begun to worship some of the Hindu deities.

Agriculture

Science and Practice of Agriculture in India

—Rao Bahadur B. Viswanath

Rao Bahadur B. Viswanath reviewed the progress of agricultural research in India with reference to agricultural practices in the country, and directed attention to some important problems. The address is in the main an analysis and synthesis of the existing data from the laboratory and the field, which leads to the important issue, namely, the building up of the soil. He said that Indian soils and agricultural practices were several centuries old and that research was concerning itself, as it should, more with the details of existing practices than with the evolution of wholly new methods, whose success was doubtful, and said that the aim of research was to build up on the existing system a state of agricultural practices suited to the conditions of the soil and the resources of the cultivator who was always ready to take up any improvement suited to the conditions with which he was faced.

Speaking of the work on soils, Mr Viswanath said that the aim was to maintain the high productivity of the soils that were already rich, to restore to normal those soils whose productive capacity was impaired, and to increase the yield of soils which were originally poor. He referred to the scientific studies directed to the attainment of these objects, discussed the important differences between Indian and European soils, explained the lack of success in India in the application of many of the results and practices found suitable in those countries and stressed on the necessity for a different outlook on the applied aspects of soil science, particularly with reference to arid and semi-arid soils of the country.

The Rao Bahadur then discussed the work on manures and fertilizers during the past quarter of a century and said that the evidence clearly established the importance and suitability of organic manures to Indian soils. In regard to fertilizers, he said that the theoretical possibilities of artificial fertilizers were almost limitless but that their achievement on Indian soils was limited by the organic matter supply to the soil, and pointed out the necessity for husbanding our resources of organic manures and for utilizing them to the fullest extent possible. He drew pointed attention to the evil consequences of intensive cultivation and the intensive use of fertilizers without the necessary accompaniment, namely, organic matter and organic manures. Organic matter was the life of the soil and if organic manures were neglected we should be doing four things. Firstly, the fertility of the soil would not be maintained, secondly, artificial fertilizers would not be used to the fullest advantage, thirdly, the cropping power of the improved seed would be reduced, and fourthly, the nutritive value of food crops would be low.

Rao Bahadur Viswanath finally referred to problems of food and nutrition and discussed the problem both from the point of view of quality and quantity and said that in both these directions soil condition played a prominent part. He referred to his own work and that of McCarrison on the subject and said that manuring contributed to the nutritive value of the crop and in this respect organic manures were the best in endowing a crop with a high nutritive value. In regard to quantity, the Rao Bahadur showed by calculations that our present production of food crops was enough for the proper feeding of only two-thirds of the population and that there were considerable scope and possibilities for increasing. This, he said, depended on the building up of the fertility of the soil and pointed out in the address the ways and means of doing it.

Medical and Veterinary Research

The Relation of Animal Nutrition to Public Health in India

—Colonel A. Olver

Col. Olver in his presidential address discussed the many and varied problems which are involved in providing an adequate diet—for farm livestock as well as for the people—at a cost which is not prohibitive for the comparatively poor. He suggested ways in which it seems possible, by proper attention to the nutritional requirements of farm livestock, to make available at reduced cost larger and better supplies of the protective foods of animal origin, *e. g.*, milk and eggs, on the essential importance of which great emphasis is laid by the Health Organization of the League of Nations. Reference was made to the pioneer work carried out by McCarrison, Voit, Theiler, and Orr with regard to what consisted of the ideal diet. Their investigations clearly demonstrated the causative role of mineral and vitamin deficiencies, which reduced the resistance and increased exposure to infection, in a wide range of stock diseases, in various parts of the world. Due largely to their elusive nature, vitamins were long taken to exist only in the imagination of the medical researcher, but happily their importance is now no longer disputed. For example, it has now been clearly demonstrated by experiments done with cattle that a vitamin A deficiency is the main cause of a specific form of blindness in them, only to be cured by an adequate supply of green stuff. Experiments also revealed that vitamin A deficiency in the mother cow affected the calves as well, many being born blind or losing their eyesight soon afterwards. It is therefore rational to assume that the milk of cows maintained in city dairies where adequate supplies of green fodder are costly and difficult to obtain cannot usually be considered a satisfactory food, particularly for children. This point deserves more attention than it has hitherto received from the general public.

It has been clearly shown by Aykroid and others that striking improvement in health and physique can be effected, at comparatively small cost, if the consumption be increased of skimmed or separated milk or of milk-powder—in which all the proteins and mineral salts of whole milk are preserved, almost intact

Regard must also be paid to the quality of the proteins available in foodstuffs of animal origin, the essential importance of which is now recognized by dieteticians. The quality of amino acids is a factor in relation to which the nutrition of farm livestock and indeed the crops on which they are fed must play an important part in human nutrition. It is thus essential that facilities should be provided for systematic research on the composition and proper conservation and utilization of such fodder and other food materials as can be made available at reasonable cost without sacrificing quality. How to make the production of suitable fodder crops economically possible in India where the agriculturist is handicapped by his limited capital resources is an intensely difficult problem. It is wrong to adopt a defeatist attitude in this matter. Indeed, the scientists of India could turn their attention to no greater or more stimulating task than that of providing an increased supply of cattle foods of good quality all the year round and of finding ways and means of developing in Indian villages a system of balanced agriculture by which the people could be better fed and the wealth of the country increased. In India agricultural science and animal husbandry should be intensively applied to the problem of the economical production of the protective foodstuffs of animal origin, an increased supply of which is particularly necessary for the proper health and development of the people of this country. "I suggest," Col. Olver said in concluding his address, "that the solution must to a very large extent lie in educating the public as to the essential importance to health of an adequate and sound supply of milk and other foodstuffs of animal origin and in providing better facilities for their production, preservation, transportation and marketing, so that village cultivators and stock-owners may be able to produce more fodder crops, to supplement the grazing available, more and better farmyard manure or compost, and better stock; thereby increasing their income and the nutrition of the family while maintaining the fertility of their holdings and making a substantial contribution to the maintenance of public health."

Physiology

Physiology in India

—Lt. Col. S. L. Bhatia

In India as elsewhere, the history and growth of physiology were inseparably connected with those of medicine.

Medicine had been practised and taught in India from times immemorial. The system of medicine indigenous to the soil was the Ayurvedic. Subsequently the Unani or the Greaco-Arabian system was introduced. In any system of medicine, some hypothesis as regards the normal functions of different organs of the body was essential, in order that morbid processes occurring in different diseases may be given a rational explanation. The physiology of the Ayurvedic system consisted of certain 'humours' which pervaded different parts of the body. The

Unani system was noted specially for its chemistry which had its origin in Arabia. Its physiology was mainly that of Galen.

Then he described the steps that led to the introduction of modern medicine and physiology into India. It was to Lord William Bentinck, the Governor General, that the credit was largely due for initiating higher medical education in India. In 1833, for improving the Medical School in Calcutta, he appointed a committee whose deliberations had a most profound effect on the future course of medical education in India. Lt. Colonel Bhatia then briefly described the origin of the medical colleges in Calcutta, Madras and the Grant Medical College, Bombay, the three oldest medical colleges in India, where the teaching of modern medicine and physiology first started. Subsequently numerous other medical colleges and schools were established.

Laboratory physiology is not an end in itself, but a means by which we can understand the larger problems of life, and specially human life on this earth. It was a melancholy fact that in proportion to the knowledge of physics and chemistry the knowledge of biological sciences in the country was comparatively meagre. And yet in considering ways and means to bring about social reconstruction, and physical well-being of the people, a knowledge of physiology was indispensable.

The subject of bodily nutrition was the special domain of the physiologist. During the last 25 years or so very important investigations had been carried out in the field of the qualitative side of dietetics, specially the biological value of different proteins of animal and vegetable origin, and of the special significance of the mineral constituents of the diet and vitamins. He appealed that the subject of nutrition in India needed to be investigated from many points of view. To the physiologist it offered great opportunities for original research work. He trusted that many workers would be attracted by it, for the knowledge thus gained would be of direct benefit to our countrymen.

There was a tendency amongst workers in India to investigate normal physiological constants here. This information was of the utmost value, as it would indicate any differences that might exist when compared with data from European countries. It would throw light on any racial or environmental variations that may occur. We should thus have a basis for racial or anthropological physiology—an important branch of human physiology which had not received sufficient attention hitherto.

Another fruitful line of physiological investigation was to ascertain the factors concerned in the adaptation to tropical conditions.

In the preclinical group of subjects physiology occupied a position of the first rank. There had been a great deal of discussion in recent years in England and elsewhere regarding the scope and function of this preclinical instruction. The wide gulf that separates the preclinical and clinical sciences should be bridged and there should be continuity of instruction in the preclinical sciences in the clinical years.

In conclusion Lt. Colonel Bhatia said that the two greatest needs of the hour in the scientific world in India were to have more scientific workers of first-class ability, and to have harmony and good-will amongst them. Gatherings such as these, apart from promoting scientific discussions and advancement of science brought about unity and friendship amongst the workers. They established such contacts as were not possible in any other way. He hoped that the Section of Physiology would promote solidarity and cordial relations amongst all the physiologists in India. Thus, physiology will make a great headway, and its progress will be a pride to us all. 'Let us therefore, march forward and fulfil our mission of serving Physiology with faith, hope, and charity, with faith in the ultimate benign aim of our science, with hope which will strengthen all our efforts, and with charity in which, as men of science to be worthy of our vocation, we must live, move, and have our being.'

Psychology

The Social Mind of the Individual

—Prof. K. C. Mukherji

Social relations are essentially mental. In the individual's mental life some one else is invariably involved. There are not at first individuals and then a social unity, as there might be bricks and then a pile of them.

Some believe that collective consciousness is the highest form of psychic life, and society is the real god. Any alleged superiority of social mind can hardly as a rule be maintained. If a wave of emotional agitation sweeps through the group each may become less than himself, less critical and more suggestible. There is a considerable tendency to change one's opinion as a result of discussion, but it is experimentally observed that the females profit more by this discussion than the males. We observe practically that the number of jurors is increased to decide cases of murder while to keep the look-out for the safety of the ship only one man, and not ten, is employed. The weight of responsibility is divided among the members of the group and weakened in proportion for each man. But for this diminution of the sense of responsibility man can hardly condemn another to death. The group or committee decision is sometimes altogether irresponsible and may only be an intellectual necessity to avoid the crushing weight of high individual responsibility.

Social consciousness follows almost a cyclic order of development. The individual is more a social outcome than a social unit. The child is not an individual when he enters into the society but he grows into an individual by social interaction. The outline of the individual gradually appears, and at every stage it shows the pattern of the social culture of which he becomes a specification. The social culture in the last analysis comes from the individuals themselves. So individuals should be not merely static conformists to, but creative artists of, culture. A non-creative personality or a culturally passive mass is a failure, educational as well as social. So the political or legal organization should have only secondary value as existing for the sake of cultural institution and activity.

The consciousness of the family group prepares the child's mind for and accentuates the development of wider group sentiment. The family sentiment and the national sentiment are equally strong in Scotchmen, especially the Highlanders. The family sentiment is very keen among the Japanese who are also noted for their high national spirit. This is also true of Germany and Italy. The people of East Bengal are noted for their national outbursts, but their sentiment for joint family system is also highly remarkable. Although any vital connection can hardly be established in view of the low sense of nationality possessed by primitive people in spite of intense family sentiment, but still the importance of the mental effects of family life in relation to the foundation of national sentiment should be no less insisted on than the importance of the organization of the family life for the material welfare of the state, and it is probably true that any barrack system of rearing up state children, if introduced, would be disastrous to the growth of national life. There is no reason to find in the family a natural menace to the development of wider social feeling. Unless narcissistically fixated and concentrated the family sentiments aid rather than impede the development of higher social sentiments.

Peoples are greatly moulded by their physical environment. In India the astounding magnitude of the objects and the appalling character of the devastating forces of nature stimulated the uncritical minds of the people into grotesque fancies which probably led them to portray gods with many arms, three eyes, and terrible visages.

There is some evidence that the crossing of closely allied stocks does conduce to increase of vigour and energy of mind and body and also to the variability of the stock for the production of persons of exceptional gifts. The Chinese have a high average ability and are a relatively pure race but their culture has stagnated for want of men of exceptional capacity. So the rigour of the exclusive caste system for the maintenance of the purity of blood is not biologically sound. But the crossing of the widely different stocks is supposed to produce an inferior race. So the Eurasians of India are said to be of a comparatively poor race. But any universal characterization of the Eurasians is risky when the unit qualities of the parental stocks are not blended and the individual of a blended stock is a mosaic of such unit character.

Semmer concludes that social or racial prejudice is based on recognition of differences, but prejudice simply because of differences does not exist. There is no feeling of hatred between the Spaniards and Indians in spite of differences in colour, speech, habits, and dresses. The difference is only an element in the total situation, sometimes it may be the symptom and not the cause of the disease. The main determinant consists in the baulked impulses of the politically, economically, and culturally dominated group. Differences are emphasized because they offer the readiest rationalization for defence against real or fancied dangers. It is for the accentuation of the dynamic relation that the Hindu-Muslim tension exists. The policy to multiply such relations of a group with different groups is destructive of its vitality. When any tension occurs the reaction may aim at the immediate extermination of the threatening force for the restoration of the intergroup equilibrium, but history shows that men cannot be made to change their opinion by direct coercion. This is an instinctive mode of reaction in which the end is directly aimed at and is characteristic of the lower order of animal behaviour. Reason works through stratagem in a round-about way. The strategy that reason is to employ in liquidating the baulked impulse of social prejudice should be far remote from the end and will prove efficient in proportion as it operates unconsciously of the goal. This very remoteness of the measure of the social process is the cause of its great efficiency. This is somewhat of the nature of a weight the power of which, when thrown on the longer end of a lever, is multiplied in transmission. Gandhiji's Satyagraha movement to stop the drinking habit of the masses fails because of its very clear and direct attack upon the end. Improvement of conditions, introduction of good music, drama, education, etc., would, however slowly, produce a more stable effect. So legislation often fails to effect social amelioration. In flattening a warped iron-plate strokes are to be judiciously administered first outside the warped part, otherwise new defects would be produced. Should we think that humanity can be more readily straightened than even an iron-plate ?

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Industries and Scientific Research

IN two editorial articles published in SCIENCE AND CULTURE, pp. 591-594, we tried to give our readers an idea of the organization of scientific research in the United Kingdom in aid of British industries. The establishment of the department of scientific and industrial research and the setting apart of a sum of 1. 3 million pounds from the treasury is in itself a sign of the great importance attached by the British Government and the manufacturers to the need of scientific research for the welfare and future of British industries. We commend our readers to the perusal of these articles inasmuch as a background of knowledge of conditions prevailing in other countries will help in clarifying many misconceptions which exist in India regarding the development of fresh industries and the welfare of the existing ones in this country.

As illustrations of these misconceptions prevailing in this country, we may refer to the views which are being advocated by official and important persons that the university education in this country is too academic and that no higher type of research should be encouraged or financed except such as has a direct bearing on the existing industries of the country. According to this class of critics, researches on pure sciences, such as mathematics, astronomy, atomic physics, etc., are a luxury for the country. They maintain that all scientific men should spend their time in trying to find out use for our waste products and discover new manufacturing processes in aid of existing industries.

Without entering into the merits of the issues raised, the universities might well reply that their function is to train the students in the fundamentals of basic science—that it is no business of theirs to undertake any work for the benefit of other people, who will make all the money out of their discoveries. It is therefore extremely necessary that the two points of view be reconciled and a joint programme, which will be beneficial to the country as a whole and will satisfy the critics, be chalked out.

We may remind our extremely practical-minded critics that all the arts and crafts which are at the bottom of modern industries have their origin in scientific discoveries made within the last two or three hundred years. Take subjects like metallurgy, electrical communication (telegraph, telephone, and wireless), the various chemical industries (manufacture of drugs, dyes, soaps, fertilizers, toilets, cosmetics, paints, colours, varnishes, etc.), the medical industries (preparation of sera, vaccines, radium and X-ray treatment), food industries (storage of foodstuff based on refrigeration), transport (railways, automobiles, and aeroplanes), and the countless other modern arts and crafts which have revolutionized modern life not only in its industrial but also in intellectual, economic, and social relationships. All these have their foundations in pure researches carried on in laboratories within the last two or three hundred years. When one looks at the giant generating plants of an electric supply company distributing light, heat, and power over a vast city like London or New York, one should not forget that these gigantic plants had their origin in the little iron ring or copper coil with which Faraday worked in an underground room near the Piccadilly Square. The same thing can be said of the gigantic concerns whose very vastness and efficiency strike the admiration of non-scientific men. Those who are responsible for the planning and the management of these concerns must have a thorough and sound grasp of the fundmentals of the science out of which they have evolved.

The next point to notice is that science has not only given birth to all these modern arts and crafts but continues to develop them. Everyday as a result of an obscure discovery made by some academically-minded person and its clever use by practical-minded people the old established methods of manufacture are being discarded or radically altered. There is no room in the modern world for any industry which continues to rely on old, time-honoured methods.

When these facts are clearly realized, there will be no difficulty in finding out the nature of the real duty of the universities to the community. The scientific staff of the universities will be doing a great disservice to the country, if they give up doing research on fundamental and basic problems of science, and training up the students under their care in the latest advancement in their particular subject. *If they have to undertake any industrial work it can be only supplementary to their fundamental duties.*

Let us explain this point of view a little more in detail. Let us take a well established chemical industry in this country manufacturing chemicals, pharmaceutical products, dyes, etc. Every manager of these industries is aware that those responsible for actual manufacture must have a good grounding in the fundamentals of organic and physical chemistry ; when their old process of manufacture is threatened by some new invention the staff should have the requisite knowledge and outlook to devise methods for meeting the competition. How can this be done if their staff do not consist of men who have been trained by professors who are directly engaged in high-class research work ?

The wisdom of this maxim is illustrated by the practice in all German industrial concerns where they prefer a PH. D. trained under a distinguished university professor to a diploma-holder from a technical high school. Their argument is that a PH. D. can pick up within a short time the routine process of their manufacture, but they want from him new ideas which they can utilize for improving their own position or regenerating their old processes of manufacture.

It, therefore, appears to us that those who are advocating discouragement of pure research in the universities are doing a great disservice to the country. If these ideas are given effect to, they will result in a lowering of the standard and ultimate inefficiency. We advocate a middle course : The industries should supplement university finance by giving subsidiary grants which will be spent for industrial research work under competent professors by a staff of research fellows and students who have the requisite knowledge and training in their respective sciences. At the present time, all universities are turning out surplus science graduates, who have proved somewhat embarrassing to the Government and the public. The best way out of this position is to employ them in industrial research which will be beneficial to the country.

A very fine example in this direction has recently been set by Messrs Steel Brothers of London who, being interested in the extraction of petroleum in the Punjab area, secured the co-operation of Professor S. S. Bhatnagar, Head of the Chemistry Department of the Punjab University, and gave him financial support by making grants for a period of five years at the first instance. This enabled Dr Bhatnagar to carry on his research work on petroleum with the help of a staff of research assistants paid out of these grants. Messrs Steel Brothers have now increased and extended these grants for another period of five years. We quote below somewhat in detail, the correspondence that passed between the Company on the one hand and Prof. Bhatnagar and the Punjab University on the other.

> Extract from letter dated 10th August 1934 from Messrs Steel Bros. & Co Ltd., London, to the Vice-Chancellor, Punjab University, Lahore.

Subject to certain conditions we have agreed to place at the disposal of Prof. S. S. Bhatnagar, a sum of money for research work on petroleum and allied subjects which will be paid in equal instalments over a period of five years. This is being done in recognition of the ability of Prof. Bhatnagar in solution of certain problems connected with mud and oil and the recommendation of our representatives who have seen something of the equipment and type of work which is being done at the University Chemical Laboratories.

Salaries of research assistants - Working on the petroleum problems	Rs 9,600/-	per annum.
Chemicals and Apparatus	„ 3,000/-	„ „
Honorarium to Prof. Bhatnagar	„ 6,000/-	„ „
	Rs 18,600/-	„ „

Rs 18,600 × 5 = Rs 93,000/-.

In addition to this we will pay the salary and expenses of a fully qualified British petroleum chemist who would relieve Dr Bhatnagar of the laboratory routine and detailed work connected with the new department. This is estimated to cost 10,000 to 12,000 per annum *i. e.*, 50,000 to 60,000 in five years.

The results which in our opinion justify the *taking up of patents will be exploited by us*, and such patents will be jointly in the name of Steel Bros. and Dr Bhatnagar and/or his chemists. We understand Prof. Bhatnagar proposes to spend a large portion of any profits for the encouragement of industrial and chemical research in your province under the auspices of the Punjab University.

> Extract from letter dated 4.8.36 from Messrs Steel Bros & Co. Ltd., London, to the Vice-Chancellor, Punjab University, Lahore.

As a result of Professor Bhatnagar's visit to this country and our discussions with him in connection with the work which is being carried out under the scheme inaugurated in your University in 1934, we have the the pleasure of advising you that we are prepared to extend the scheme for a further period of five years from the expiry of the present arrangements. This will give the scheme ten years' life... The Punjab University will thus be associated with industrial development for a long period.

As from 1st December next, we propose to increase the amount payable by us under the Agreement dated 12th October, 1934 (Clause 5) from Rs 800/- to Rs 940/ p. m., this money is to be utilized for increasing the pay of the research assistants.

We will make suitable arrangement for the medical attention of the assistants with one of Lahore doctors.

Prof. Bhatnagar has suggested that in order to consolidate the scheme and give adequate protection to their research workers, a Provident Fund should be instituted. We are, therefore, agreeable to start a Fund for these workers. Prof. Bhatnagar has suggested that this Provident Fund could well be operated under the Registrar of the University according to usual rules and practices, in which case the University would pay the interest earned on such funds.

Compared with figures of Rs 150,000 given in our letter of 10th August, 1934, as the estimated cost of the scheme to the company, we estimate the total cost to the company on the extended period will be *approximately* Rs 400,000 which includes payment of salary and expenses of a senior European chemist whom we have decided to post at Lahore.

We feel that the results of the scheme under the able direction of Prof. Bhatnagar will eventually prove not only of commercial value but also of general scientific value to the academic world.

> Extract from letter dated 18. 9. 36 from Prof. Bhatnagar to the Vice-Chancellor, Punjab University, Lahore.

I have every hope that this scheme will become a permanent feature of our activity if in ten years some of our processes are adopted by other countries and business organizations. The equal share of the University in the 50% royalties payable to me in case a process is leased out or sold to any firm other than Steel Bros. may bring some money to the University within the next few years. This is of course a matter of chance but probabilities seem to be growing. These monies will be spent by the University as desired by me for encouraging medical and scientific research under the auspices of the Punjab University, particularly with a view to relieving humanity of suffering from disease.

In my negotiations with Messrs Steel Bros. I have tried to be selfless and, as you will no doubt appreciate, I have not taken advantage of the success of research carried out in my laboratories by asking the firm to increase my emoluments. I have on the other hand proposed that any additions to their contributions should go to benefit the researchers and to put the research scheme on a more permanent footing.

The above correspondence gives in some detail an account of the recent individual research policy of the Punjab University. It will be clear from this correspondence that the company has been alive to the fact that industrial and pure research must go on side by side, and the former cannot prosper without the aid of the latter. Messrs Steel Bros. have done well in realizing that research in applied science will be wrecked when divorced from pure science, and the monetary grants made by them to Prof. Bhatnagar is a clear indication of the great importance they attach to the latter. Attention of the reader is further invited to the noble example of unique generosity and selfless devotion shown by Dr Bhatnagar. It is unprecedented in this country and comparable only with the similar attitude of selflessness on the part of Dr E. P. Roux who made over to the Pasteur Institute the Osiris Prize valued at £4,000 awarded to him for his discovery of the anti-diptheria serum. No other country is so much in need of encouragement in industrial research as India where the closest co-operation of science and industry is urgently called for.

The example set by Messrs Steel Bros. and Prof. Bhatnagar should serve as a model to the industrialists of this country. Instead of indulging in irresponsible criticism of the activities of university teachers, they should try to enlist the help of university professors and their research scholars by giving *additional* grants to universities to be used for industrial research with the help of surplus graduates. We are not aware that any Indian firm has so far come to the aid of any Indian university by giving research grants from its funds, though many of them are in a position to do so. We may mention in this connexion a pamphlet issued by the President of our Association, Sir P. C. Ray, who advocated a similar action on the part of Messrs Bengal Chemical and Pharmaceutical Works of Calcutta. It is just forty-four years ago that Sir P.C. Ray, then a subordinate professor of Chemistry in the Presidency College, Calcutta, started the B. C. P. W. with a capital of Rs 800/- which he collected out of the savings of his small income. To-day, this has grown into a giant concern with total assets amounting to half a crore of rupees and employing a large number of trained chemists and skilled labourers. It has done a great and unique service to the country by producing manufacture of drugs and chemicals on modern lines. But we must not forget that what the Bengal Chemical is to-day is mostly due to the selfless devotion of Sir P. C. Ray, who has been not only the promoter, expert, and initiator of ideas but is also its best salesman. If he decided to keep a reasonable share of the profits of the managing director, the amount would have come to no less than Rs 15 lakhs. When, therefore, he issues a plea that the directors of the B.C.P.W. should hand over an equivalent sum of money to the Universites and to the hospitals and clinics in the country for aiding scientific research, it should be the duty of the directors to meet his wishes and devise methods for the proper administration of these funds. We commend the directors to a proper consideration of the terms of agreement between the Punjab University represented by Prof. Bhatnagar and Messrs Steel Bros. The request of Sir P. C. Ray, though made apparently to the B.C.P.W. only, is general and can be applied equally strongly in the case of every industrial firm of this country. Every industrial organization in India ought to realize that it is high time now that a close co-operation between science and industry existed. Scientific industrial research very rarely receives at present all the encouragement which it deserves, and the country must wake up to its call without further delay.

Some Plant Diseases and Pests of India and their Control

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(Continued from the last Issue.)

Diseases of the Cereals

The annual loss to the world due to the "rust" disease of wheat is about 60 crores of rupees in which India's share is about 4 crores. There are three kinds of rusts—black (dark brown) rust (*Puccinia graminis*), yellow rust (*P. glumarum*), and orange rust (*P. triticina*). The orange and yellow rusts appear earlier than the black. Their onset is first marked by the eruption of brownish pustules on the leaves, leaf sheathes, and stalks. These pustules very soon burst, exposing a rusty powder (uredospores) which blows about in the air and infects other wheat plants. Later in the season often the same pustules become black due to the formation of thick-walled sports (telentospores) which undergo a period of rest and germinate on the return of favourable conditions. But the products of their germination cannot re-infect the wheat plant. In foreign countries they grow on an alternate host which in the case of black rust is barberry. On barberry they produce yellowish spores (aecidiospores) in little cups and these have the power to infect wheat plant and produce the original symptoms. In the plains of India the alternate host (barberry) does not grow and the brownish rusty uredospores cannot withstand the summer heat. No satisfactory explanation of their annual recurrence has yet been given, but a possible theory, based on extensive observations, has been propounded. It is said that in the plains the disease is caused by the uredospores blown down from the hills where they oversummer in the cooler temperature. Uredospores of a particular rust have been caught from the air well before its appearance on the crop at the locality. Living spores have actually been found at various altitudes on self-sown plants and tillers during the months when there is no wheat crop. The yellow rust has been found to survive at Muktesar (8,000 ft), the brown rust to oversummer at Almora (5,400 ft), and the black rust to do so even at lower altitudes (3,000-4,000 ft). It is, therefore, clear that if wheat cultivation be stopped in the hills where it is only about 5% of the total area acreage of this crop in India, for at least 3 years there will be no wheat plant there to harbour the parasite in summer for its annual exodus to the plains. No direct method for the treatment of rust is known, and practically the only way is to introduce rust-resistant varieties.

Another important disease of wheat is known as the loose smut (*Ustilago tritici*) where instead of the normal ear the infected plants show ears with black powdery mass which, when blown off, leaves a bare stalk behind. Ordinarily the damage varies between 1-10%, but a serious outbreak in the Jhelum canal colonies showed as much as 30% infection. The parasite lives within the grain and the most satisfactory method of control is to soak the seed grains for 10 minutes in water hot enough (129°F) to kill the parasite without seriously injuring the seed. In many parts of India, where the summer temperature in shade reaches as high as 115°F, the water may be heated with sun's rays. The bunt (*Tilletia*) disease of wheat is not easily detected, because the diseased ears have the outward appearance of normal ones, but if the grains which are slightly darker be broken they are found to be filled with a black greasy spore mass strongly smelling of rotten fish. During threshing the effected grains get broken and the spores adhere to the clean grains.

SOME PLANT DISEASES AND PESTS OF INDIA AND THEIR CONTROL

When the seedling comes out they infect it, live with the plant, and when the ears are formed they fill the grains with the black mass. The most effective treatment is to dip the seeds before sowing in either a 2% solution of copper sulphate or ½% solution of formalin in water. Care should be taken to avoid contact with bunt spores after this operation. Of the three species of bunt known to attack wheat, *Tilletia indica* is restricted to the cooler regions of the plains, and in Karnal is responsible for about 20% damage, while the other two (*T. caris* and *T. foetens*) are confined to the north-west hilly tracts and cause about 30-40% damage near the Simla hills.

Among the insects, the grasshopper which cuts off the wheat plants near the ground is widespread in Bihar and West Bengal, being more frequent on "rabi" crop. If serious, the whole field has to be resown. Treatment consists of bagging the insects and killing them. Another method is to grow wheat mixed with mustard which serves as a "trap-crop". Mustard grows quickly and attracts the insects and can afterwards be weeded out.

Barley is attacked by the same black and yellow rusts that attack wheat but the forms growing on barley can not infect wheat and *vice-versa*. The loose smut of barley is similar to that of wheat and treatment is also similar. Oats are infected by smut which is present everywhere; at Dehra Dun about one-tenth of the crop is annually lost from it. The symptoms are similar to those on wheat, but the covering over the powdery mass remains for a longer time. Treatment with ½% formalin is quite satisfactory, and an experiment showed that it reduced the disease from 1 plant in every 10 to 1 in every 1,700.

Jowar claims a total area of 21 million acres in India, and the smut disease (*Sphacelotheca sorghi*), in which the individual grains are transformed into minute sacs filled with a black dust, causes a loss of 20-25%. In Bombay Presidency alone it costs about 2 crores of rupees and for the whole of India the loss must amount to several crores. The disease can be very successfully prevented by immersing the seeds either in ½% formalin for 2 hours or in ½-3% copper sulphate solution for 10-15 mins. The Bombay authorities, by their propaganda with demonstration and distribution of pamphlets, created so much interest among the cultivators that whereas in 1913-14 the number of one-anna packets of copper sulphate, each of which suffices for 4 acres, sold was only 4,000, in the next year the number of packets sold increased to 44,000. This must have resulted in a saving of about 3 lakhs of rupees. By widespread and continued use of this preventive method the disease can easily be eliminated from this country.

A very widespread disease of rice, especially in East Bengal, is known as "Ufra" and is due to a microscopic worm (*Tylenchus angustus*). The insect lies on the surface of young parts and sucks out the juice. The plants are weakened resulting in complete or partial sterility or killed outright. The loss is very great. The estimate made in a small portion of the Bhowal pargana of Dacca showed that over 2¼ lakhs of rupees worth of paddy is destroyed annually. The parasite lives in the dried stubbles that are allowed to remain in the field after harvest, and with the coming of the floods and the high humidity of the rains, they grow and infect the crop. Dry conditions are unfavourable for the parasite and so the early 'aus' crop is comparatively immune. A diseased plot will inevitably give diseased crop if stubbles are allowed to rot, so it is absolutely essential to remove and burn them. Rice is also affected by caterpillars some of which feed on leaves often completely destroying them, some cut off the half-ripe ears at night, or some bore the stem and ears are not produced. These are popularly called *dhaner leda poka*. Clean cultivation, lighting of bonfires near the fields which attract the insects, and pouring kerosine oil (3-4 quarts per acre) over the standing water and then shaking the plants with long sticks or ropes so that the insects fall on kerosine and die, are the remedial measures to be adopted. Stored rice is often affected by weevil and moth which bore minute holes in the grains. Thoroughly dry conditions and fumigation with carbon bisulphide will prevent them. The bunt

(*Tilletia horrida*) of rice is very difficult to detect as the outward appearance of the diseased grains is exactly like that of the normal. Attention was first called to it by a complaint received from Berlin about the universal occurrence of its spores on rice imported from Burma.

Diseases of the Sugarcane

The most serious of the diseases of the sugarcane is the red rot (*Colletotrichum falcatum*) which in India is the greatest obstacle to successful cane cultivation. In the beginning the upper leaves begin to lose colour and droop. The midrib of the leaf may be reddened and black dots appear on them. The disease progresses downwards and ultimately the whole stool is affected. In bad cases little or nothing of the crop may be left undiseased. Diseased canes in young condition, if split open, show an unevenly reddened core near the base and give off a sour smell. Redness may be due to several causes but definite red blotches with transversely elongated white centre is quite characteristic. In the mature condition the diseased canes dry up, become dirty red and light in weight, get easily broken, and cavities appear inside, which become filled with cobweb-like threads. The juice fails to crystallize. The disease recurs through the use of diseased setts which every year before planting should be examined for redness. Rotten setts, partially infected canes and debris, if allowed to remain in the field, become the source of infection and should be burnt. Ratooning should be stopped and long rotation of about 5 years should be practised. The disease is commonest on the thick Java and Mauritious canes. Thin canes are more resistant to this but more liable to be attacked by the smut disease and the yield is poorer. Breeding thick resistant canes is possible but their immunity is temporary. If proper precautions are not taken the disease continues year after year with progressively increasing accumulation until epidemic severity is reached and enough heathy setts for the next crop may be unobtainable. This actually happened some time ago in the Godavari delta and some parts of Bihar where the disappearing crop had to be replaced by healthy canes brought from outside. It is extremely difficult to rid a stock of this disease and therefore when new plants are imported they should be obtained from private nurseries where they are kept healthy or from the government farms. Only by such means the disease can be kept within reasonable limits.

Amongst the insect diseases the borer, which bores into young canes causing them to wither, is responsible for about 8% damage in every field. The total annual loss to India is one crore and thirty-three and a half lakhs of rupees plus another twelve lakhs as a loss to the excise. The affected parts should be burned so that the new ones may remain healthy. White ants (Badla poka) are also serious enemies to young canes, because they cut the young plants near the ground. Green farmyard manure should be avoided, young setts should be dipped in copper sulphate solution before planting and kerosine oil should be poured over the nest of the ants.

The sugarcane mosaic, a virus disease, is widespread and in the affected plants the yield of sugar is reduced up to 30-35%. The leaves become mottled and the size of the canes is reduced. Some varieties are totally infected and others are more injured than the rest. In the Punjab the size of the red Mauritious canes reduced from 6-8 ft to only 3-4 ft due to mosaic of long standing. The disease is transmitted through sucking insects. Setts for planting should be selected from mosaic free plots.

Diseases of the Fibre Crops

The pink-boll worm—a caterpillar which infects cotton bolls—is widespread and in U. P. is responsible for damage of about 20% of this crop. These caterpillars are kept in check by infecting them with certain insect parasites (*Phogas*) which are cultivated. The leaf curl in which the young leaves curlup is a virus disease and is transmitted by the white fly, an insect which visits the plants. This virus also lives on the garden zinnias.

The wilt of cotton is caused by a fungus (*Fusarium*) which can live in the soil. A three years' rotation is therefore practised. Planting of wilt resistant varieties is also of very great help. Ordinary varieties may show about 83% wilt, the Wagale variety about 4% but the Buri cotton is totally immune. Both cotton and jute are affected by root rot (*Rhizoctonia*). The seedlings are killed and the older plants are weakened. The infected area turns black and shows minute globular bodies. In the Punjab the damage done to cotton varies from 1-15% often extending up to 60% in some plots. Taking the average damage to be 2·5% the annual loss from the cultivation of 2¼ million acres in the province, is 15¾ lakhs of rupees. Rotation of crop, and good manuring is necessary. In an experiment it was found that the disease was entirely absent in soil with sodium sulphate while in the one without it 744 out of 1342 plants became infected.

Diseases of the Fruit Trees

In 1906, a serious epidemic of bud rot (*phytophthora*) of the palms was reported from the Godavari delta. In the palmyra palm, which was attacked most, the top was rotten, many of the leaves were shed, the flow of toddy was checked, and in bad cases the palm was reduced to a bare pole. The control measures adopted were an 'operation' consisting of carefully cutting away the diseased tops without much injury, burning it, and the application of Bordeaux mixture to the leaves of all the plants within 25 yards' radius of the diseased ones. At first these measures did not succeed because the people were reluctant to cut the tops and even when cut they stole away the diseased leaves to thatch their houses. Thus the parasite was not killed and infection was easily spread by wind, insects and tools. But since the passing of the Madras Pest Act in 1918-19, which threw the whole blame on the owners, the campaign against the disease became eminently successful. In Kistna out of 375 trees in a plot 247 were infected and the owner abandoned working it, but after treatment all recovered. Between 1908-1920, about 500,000 trees were cut at an expense of 300,000 rupees and though these were destroyed millions of other plants were saved. A similar disease of the Areca palm (betelnut) in Mysore, the loss from which was estimated at 3 to 4 lakhs annually, was combatted along the same lines. A single spray of 40 gallons of Bordeaux mixture per acre cost only 8-10 rupees, but the increased profit amounted to over 100 rupees. In South Malabar the increased profit per 100 trees was over 20 rupees, and the owners were so satisfied with the results that they requested the Government Mycologist to continue this useful work. Cocoanut palm is also similarly affected and the treatment is similar. The cost of spraying is only 5 pies per tree, being the cost of 1 or 2 cocoanuts, but the increase in yield is about tenfolds.

A serious insect disease of the palms is that caused by the jet black boring rhinoceros beetle (Gobre poka) found all over Bengal. The beetle comes out at night, bores through the soft tissues of the unopened leaf and, if it reaches the core of the stem, may cause death. The insect breeds in manure heaps and rubbish which should be removed. The bored holes should be probed with a wire to kill the beetle and then closed with coal-tar.

The Mango tree is attacked by many insects of which the sucking bug is the most serious and this was responsible for the failure of the crop in Bombay in 1916. The insect sucks up juice from the growing shoots and leaves, and the drain on the tree is so much that no fruits are borne. Spraying with crude oil emulsion or fish oil soap (1:40 of water) in the flowering season gave such encouraging results that the orchardists of Bombay became eager to adopt spraying as a routine work.

A black fungoid layer of incrustation (*Capnodium*) is often seen on the leaves of mango. These grow on the excreta of the insects and by interfering with the food-manufacturing function of the leaf, weakens the plant. Resin wash will prevent insects from excreting on the leaf and so the fungus will be checked. Ripe mango fruits are often rotted by a fungus (*Gloeosporium*) appearing as minute black spots on the surface which enlarge and a depression is formed all round. Considerable damage is caused if the infected fruits are allowed to remain in contact with the healthy ones.

The last mentioned fungus on mango also causes the fruit rot of bananas and another fungus (*Botryodiplodia*) is responsible for the blackening at the tips of immature fruits. Together they cause a loss of about 20%. Propagation by healthy suckers dipped in 2% copper sulphate is useful.

Apple trees are commonly attacked by a white powdery mildew which infects leaves and fruits and also with fly-speck and sooty blotch which infect fruits. Spraying with sulphur is beneficial and this largely controlled the severe outbreak of the diseases in Kumaun and Peshawar in 1919. In the markets of U. P. many apples show a "soft rot" in which a small area presents a water-soaked appearance. The disease is caused by a fungus (*Aspergillus niger*) which enters the apples through wounds and so careful handling is necessary to prevent bruises.

Vines are seriously affected by mildew—a white powdery fungus found on the stem, leaves, and fruits. It was first noted in Europe in 1890 and within 10 years spread everywhere grapes are grown, so that the annual loss to the world now is about 600 crores of rupees. The disease flourishes in shade and is worst in cold weather, being known to cause wholesale destruction in untreated vineyards. Dusting with finely ground sulphur leaves the vines practically free from mildew. 75-80 lbs of sulphur suffice for the three applications required and the maximum cost including labour is within 7 rupees. In Bombay the number of attacked branches, after treatment, was reduced from 21% to 0%. In Madura it was claimed that the yield from 239 vines rose in value from Rs 710 to Rs 3950 and in Madras 30% more branches became marketable after treatment.

Citrus varieties (lemons, oranges, etc.) in the Punjab are attacked by wither tip (*Colletotrichum*) which gradually progresses downwards and immature fruits are dropped. The disease is a minor one in many provinces but in the Punjab it has become a major one and whole plantations of oranges are known to be adversely affected. Pruning, burning of diseased parts, and planting of only healthy varieties are necessary. Spraying with Bordeaux-oil-emulsion shows marked improvement with fruitfall checked and in a trial experiment with 330 plants sprayed with 325 gallons of the fungicide the cost including labour worked out at 9 pies per tree.

Diseases of the Pulse Crop

The best known of the diseases of the pulse-crop is the wilt of pigeon pea or Arhar. It is common throghout India but is very destructive in parts of Bombay, C.P., U.P., and Bihar where the loss may considerably exceed 50%. Normally about 10% of the crop is destroyed. It is due to a fungus (*Fusarium Uasinfectum*). There is a gradual or sudden wilting and drying up of the plants even though there may be plenty of water in the soil. Roots and the base of the stem show black streaks. The parasite lives in the soil from previous crop. Rotation of at least 3 years is necessary and wilted plants should be systematically removed and burnt. Use of superphosphate as manure favours the disease as there are five times more wilt than on fields with green manure. Resistant varieties only should be used.

Pea is attacked so severely by the white powdery mildew that it is impossible to cultivate late peas without resorting to sulphur dusting. Early varieties are less injured. The same fungus attacks beans, urid, mung, lucerne, etc. The anthracnose of beans is widespread and sometimes causes considerable loss. It is characterized by the appearance of blackish, rather sunken spots on all the parts of the plant. Diseased seeds give diseased crop and so seeds should be collected only from unspotted pods.

Pulses are attacked by the greasy surface caterpillar from which the annual loss is very great. The parasite remains concealed in cracks of the soil during day but at night comes out and cuts off the stem of the young plant near the ground. A kind of the fly lays eggs on the body of this parasite and the maggots developed from them destroy the caterpillars. Poisoned baits of bhusa, arsenic, and gur also kill the parasite.

Diseases of the Oil Seeds

A very common disease of mustard is the white rust (*Cystopus*) which is also found on a number of allied plants like the cabbage, cauliflower, turnip, radish, etc. All parts of the plant, but specially the leaves, show white blisters of varying sizes. Together with another disease the downy mildew which appears as thin white cottony growth, it is responsible for marked swelling often with violet streaks of the stem, flowerstalks and flowers up to 12-15 times the normal diameter. The downy mildew is more destructive and in 1911-12 about 90% of the cauliflower crop was found infected at Lahore and reduced the yield to less than half. Control measures for both the diseases consist in clean-weeding to remove all other plants capable of harbouring the parasite. Spraying with Bordeaux mixture is useful in bad attacks. Rotation and burning of crop refuse should be practised.

Castor is often affected by seedling blight (*Phytophthor*) which entirely destroys about 30-40% of the seedlings in bad cases and also attacks the leaves of older plants where irregular discoloured patches are formed. It is best not to sow seedlings in damp low-lying locality where the parasite gets the favourable condition for flourishing. The commonest disease of the linseed is the rust (*Melampsora*) and grows every year without fail. Bright orange-coloured patches are formed on the stem and leaves, which later in the season turn blackish. Injury caused is considerable and in severe attacks whole fields may be reddened with it and the crop may not be worth the trouble and expense of harvesting. At Dumraon (Bihar) actual loss of over 28% by the weight of seed has been recorded. Remedial measures are not known but the debris after harvest should be removed and burned.

Diseases of Tea

The diseases of tea are very numerous but the most serious is the Red rust (*Cephaleuros*) which reduces the yield of tea by about 15-20%. On the leaves it occurs as orange-yellow roundish patches but on the young woody stems they produce cankers so that the plants are considerably weakened resulting in pallor and often death. If proper steps are not taken the disease becomes chronic and whole plantations may be seriously affected. Bordeaux mixture after pruning is useful but the vigour of the tea bush must be maintained by good soil conditions. The blister blight (*Exobasidium*) remained confined to Assam for 40 years but in 1908 a disastrous outbreak occurred at Darjeeling. On the young leaves there are developed small pale or reddish spots which enlarge. On the upper side of the leaf the spots become depressed into shallow cavities with a corresponding blister-like swelling on the underside. Picking and burning of diseased leaves and spraying with Bordeaux mixture give good results. It may be objected that the presence of copper in the fungicidal spray is harmful. Though copper could be detected in sprayed tea leaves, one would have to consume 140,000 cups before the amount of copper recognized as a dangerous daily dose would be reached.

Diseases of drug and spice Crops

The wilt of tobacco is due to bacteria and occurs yearly in the Rangpore district, Bengal, where it is locally known as "rasa". 5-6% of the plants are attacked though 20-25% attacks are also seen. The parasite gains an entrance to the host tissues through wounds caused by insects or during transplanting or removing of leaves. The cultivators wrongly suppose excess of moisture as the cause of the disease and try to dry the soil but this reduces the vitality of the plants through lack of water and render them liable to infection. Conservation of soil moisture, maintenance of heathy plants, and efficient hot-weather cultivation are important. The mosaic disease, however, causes the greatest loss to this crop. Patches of lighter and darker areas appear on the leaves, especially on the younger parts. The disease is highly contagious and is transmitted through the workers in the field. Seeds from healthy plants should be used and diseased plants should not be touched before collecting the leaves of the healthy ones.

In the downy mildew of opium the leaves show a whitish cottony growth on the under-surface of the leaves which in bad cases may totally wither. The parasite grows also on garden poppy and an allied weed (*Argemone*) both of which should be removed from the neighbourhood. Infected parts should be burnt. A root rot (*Rhizoctonia*) similar to that of cotton also causes withering and death of the plants. Both these diseases together are responsible for the enormous losses found in the Government Records from time to time as in 1871, 1874, 1913, *etc.* By reducing the yield by 20% the loss in 1871 amounted to about half a million sterling.

Ginger is attacked by a soft rot (*Pythium gracile*) which is very prevalent in Rangpur (Bengal) and Gujrat. There is first a general paleness of the leaves followed by yellowing of the tips which spreads downwards resulting in withering and death of the plants. The underground ginger decomposes and forms a watery mass enclosed within the tough-skin. Treatment consists in selecting undiseased ginger for planting and in preventing water-logging of the soil. Diseased gingers should be carefully dug out and burnt. Rotation of about 3 years should be practised. Damage due to this disease is considerable and in 1904 Surat suffered a loss of about 10,000 rupees.

Great loss in Bengal is caused by the sudden wilting of betel vine (pan). This disease causes wholesale destruction in certain villages and in others takes a more or less heavy toll. The total loss probably runs to several lakhs of rupees annually. Near the ground level the stem darkens, shrinks, and becomes brittle. Three fungi are responsible. *Phytophthora* is the active agent in monsoon, *Rhizoctonia* in cold weather, and *Sclerotium* in summer. Spraying with Bordeaux mixture for the first and with ·07% kerol for the last two fungi is beneficial. Unsprayed plots show 18-30% wilt, while the sprayed ones remain free.

Diseases of the Forest Trees

Sal is infected by a bracket fungus (*Polyporus*) which causes extensive damage in Buxa (Bengal), Bihar, Gorakhpur, and C. P. Bad soil aeration and excessive shade and undergrowth favours the disease which can be controlled by altering the hygenic conditions. Borers and defoliators also cause a lot of damage and in 1916, in the Siwalik hills, they broke out in epidemic form causing death of 7,000 sal trees. The borer can be checked by covering the holes with coal-tar and the defoliators have a natural parasite, a fungus (*Botrytis bassiana*) which can be used to infect and kill the insects. The very important spike disease of the sandal wood tree causes severe loss in Mysore and South India. The attacked plants show great distortion and assume a bushy appearance. The finer roots die prematurely and no flowers are produced. Various theories like unbalanced sap circulation and other physiological causes have been put forward for its occurrence but the latest opinion is that the disease is due to a virus. The most common method of transmission is the grafting of diseased tissue on healthy stock and this should be avoided.

From the foregoing pages it is amply evident that losses which are simply staggering occur annually due to plant diseases. Much of it can be stopped by the spread of knowledge about the pests and the united efforts of the farmers, zemindars, and plant pathologists. Below is given a list of references which will prove useful to those who want to pursue the subject further.

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Psychological Methods of Measuring Intelligence

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Intelligence Tests

Psychologists for some time have been busy in trying to find out the best method of measuring the native intelligence of children. A number of tests have been laid down after experiments and tests with hundreds of thousands of children. They may be divided under two heads *i.e.* individual and group tests. The former require skilled psychologists to use them and cannot be satisfactorily used by lay men. A wave of the arm, wrinkle on the brow or a different intonation of the voice may spoil the test and make it unreliable. On the other hand, provided the examiner is well trained, the individual tests give reliable results. It must be remembered that brain capacity is non-material and subjecting it to quantitative measurements cannot possibly bring about such accurate results as one is lead to expect in scientific work. But still these individual tests give us fairly reliable indications of a child's possibilities.

Group tests on the other hand can be given to a number of children at the same time and less skilled hands can be utilized for marking and finding out the capacity.

It takes about 40 or 45 minutes of undisturbed work to examine a child individually. But the group test copies can be given to 30 or 40 or even more children at the same time and their valuation does not take more than three or four minutes per copy. But they cannot be as reliable as the individual tests ; so many factors come in the way of a proper judgment. The best course is to try group tests and in cases of doubt to use individual tests.

Some of the best known tests in use are :—

1. Stanford Revision of Simon & Binet Tests (individual)
2. Terman group Tests (Alpha tests)
3. Simplex group Tests
4. Otis " "
5. Northumberland group Tests
6. National group Tests
7. Goodenough Intelligence Tests and a number of performance and other tests *e.g.* Dr Rice's Hindusthani Performance Scale.

Performance tests are useful in the cases of children and people whose command of language is not good enough.

Principles Underlying the Tests

These tests are based on the principle that a child's native intelligence grows upto the 16th year (some say upto the 18th), after which it ceases to grow. A person may acquire afterwards knowledge at school, or college but the natural growth of intelligence stops. Hence the age-scale has been adopted to serve as the Norm. Secondly they aim at testing the higher mental processes only *e.g.* reasoning power and ingenuity and to provoke judgments about abstract matters. Lastly they would test general intelligence, not school knowledge or home training

Marking System

In the cases of individual tests, a series of tests have been devised for children who have completed three to fifteen years and a child who passes the tests for a particular year is said to have intelligence for that year. Supposing that a child who has completed the 8th year, and passes the tests prescribed for children of that year, he or she is declared to have intelligence of eight year olds. The intelligence quotient in that case is fixed at 100. But if the same child can pass the tests for nine or ten year olds, he or she will be declared to have the mental age of nine or ten. The mental age divided by the actual age and multiplied by 100 gives the Intelligence Quotient. Just as there are children whose mental age is higher than the birth age there are children whose age is below it. After holding examinations in thousands of cases and finding out the intelligence quotient, psychologists have classified children as follows :—

	I. Q.	
1.	Over 140	Near genius or genius if over 150.
2.	120-140	Very superior intelligence.
3.	110-120	Superior Intelligence.
4.	90-110	Normal or average.
5.	80-90	Dull.
6.	70-80	Border line deficiency.
7.	Below 70	Definite feeble mindedness.

Conditions Governing I.Q.

Three facts come out pointedly as the result of researches in this direction. (1) The native intelligence in a child is the result of Nature's endowment and, however much people in the teaching profession may dislike the statement, the fact has to be admitted that school education cannot help to increase it. (2) The progress of a child at school or college in acquired knowledge is in geometrical proportion to the I. Q. (3) Heredity has an appreciable influence in determining the I. Q. Children of feeble minded or mentally deficient parents tend to show a low I. Q.

Care of Superior Children

It may be mentioned that examinations have revealed the fact that the intelligence quotient can go in very rare cases as high as 180. Those with I. Q. over 140 may be regarded as gems of priceless value, not only to the family, but to the nation as a whole. Provided their health is carefully looked after and they are offered full scope for the development of their talents and for acquiring knowledge, these are likely to be the leaders of creative thought and of the nation, captains of industries etc. The highest type of education should be given to them to enable them to have full scope. If they belong to poor parents, it should be the interests of the country to offer them all possible facilities. In my opinion, help in pushing up such boys and girls is a kind of national service. Again it is only candidates who show superior or very superior type of intelligence, as judged by these tests, who should be encouraged to go up for the university education.

While I hold that it is wrong to deprive children of superior intelligence of their chances in life, it is equally wrong to help up children whose I. Q. is low to get university education, for example, after repeated failures they may get a degree or a pass. But their low I. Q. is sure to bring them down and their life career likely to end in failure. The money spent in pushing them will be wasted and would be better utilized in helping them to take up occupations for which they may be fitted by their capacity. Cases of men of subnormal I. Q. successfully doing mechanical type of work and living a decent life can be quoted in abundance.

Need for Special Schools for Superior Children

The levelling influence of the present system of education in which a certain number of children of all the above mentioned types study and work together, and because of the regulations which insist that each child must spend one full year in each class results in types 1 and 2 being lost in the masses.

It is rare for such a child to get double promotion and thus save time. The school authorities are reluctant to give it and their unwillingness may be explained by (i) mere inertia or red tapism (ii) a natural unwillingness to part with exceptionally good pupils and (iii) the traditional belief that precocious children should be held back for fear of dire physical or mental consequences. Researches made by psychologists during recent years have proved that exceptionally brilliant children are as likely to be healthy as other children, their ability is more often general than special, they are not studious above the average, really serious faults are not common among them, they are always social, are sought after as playmates, they are leaders oftener than other children and notwithstanding their superior qualities they are seldom vain or spoiled.

The present system of class grouping does not suit them, as very often the work they are called upon to do is below their capacity. Unless they are given the grade of work which calls forth their best efforts, they run the risk of falling into lifelong habits of submaximum efficiency. The danger in the case of such children is not overpressure but underpressure. Very often not having enough scope in the school room they begin to be troublesome and naughty.

I have so far taken for granted that the school work can pick out native intelligence. But as explained very early in this paper, schools focus attention on acquirements and hence are not always able to spot out superior children, who are often misunderstood and even thwarted. It is for psychologists with the help of group and individual tests to pick out such children and bring them to light. As pointed out before, the future well being of the country hinges, in no small degree, upon the right education of these children. Whether the civilization in the country moves on and up depends upon the advances made by creative thinkers or leaders in science, politics, arts, morality and religion. Moderate ability can follow or imitate, but genius must show the way.

What are we doing to pick out and push up and make the best use of the geniuses born in this country ?

In the big cities of the U. P. there are scores of high schools and hundreds of primary and middle schools. Is there a single institution which undertakes to offer special facilities to gifted children, help them to finish their courses in shorter time and push them on ? No wonder as we have not got psychologists to pick them out. But the work before us is even more laborious. The standardized tests prepared by European and American psychologists may successfully test children in Europe and America. But for the children brought up in the Indian atmosphere, they need radical modifications and the language of the tests has to be set in Indian languages. Tests in Indian languages when ready require being standardized after extensive experiments. I pray that enthusiastic psychologists would come forward and do the the work of standardization.

So far I have focused attention on brilliant children and their needs, later on I hope to deal with the problem of defective children.

Good deal of public interest has been aroused over the question of intelligence and vocational tests as a result of the publication of the Sapru Report. It is hoped that the public will now better appreciate the work of psychologists.

Experiments in Benares

During the last two or three years a system of group tests based on Simplex, but largely modified to suit Indian conditions was devised in the Hindi language and about 2100 children have been examined so far. About 40 schools have co-operated with us.

The tests proved to be very popular wherever they were used and non-Hindi speaking children regarded it as a grievance that similar tests were not given to them also.

The tests were prepared on the principle of testing various mental processes such as :—

(*a*) Ability to pick up words not in their class.

(*b*) Ability to give most reasonable answers to specific questions.

(*c*) Association.

(*d*) Ability to grasp accurately what is told and to act accordingly.

(*e*) Ability to see similar relationship.

(*f*) Putting right, things in a wrong order, *i.e.* ability to solve a tangle.

(*g*) Seeing arithmetical relationships.

(*h*) Ability to understand nice shades in the meanings of words.

(*i*) Filling up gaps in thought.

(*j*) Ability to visualise a concrete experience with certain modifications.

The tests are grouped in three classes. Those marked (*a*) are the easiest and come first. Those marked (*b*) test similar psychological processes, but are a little more difficult and those marked (*c*) are even more difficult.

Difficulties Experienced

The following difficulties were experienced in administering the tests :—

(*i*) The teaching of English in the United Provinces commences in the third class, *i. e.* before there is any chance of the mother tongue being fairly mastered. The children who were examined did not appear to have sufficient mastery over the mother tongue to enable them to give a satisfactory account of themselves when answering these tests. The defect was chiefly noticeable when they tried to answer questions on word meanings. Hindi teachers in Anglo-Vernacular schools, being the least qualified and worst paid and least supervised, do not and cannot give satisfactory training in the mother tongue and children learn to attach vague and nebulous meanings to words. For example the words **पराजित करना** (to defeat) **दण्डदेना** (to punish) **घृणा करना** (to hate) do not mean exactly the same thing, yet good many of the pupils give the same nebulous meaning to them. The common practice of using technical terms in English also results in the vernacular terms not being quite familiar to children, with the result that even when perhaps they understood the significance of geometrical figures, they did not feel sure of the meaning of the technical terms in Hindi as used in the tests. To add to the difficulties, different technical terms are used in different provinces to give the same idea. Even ordinary simple words like **पशु** (quadruped) **जानवर** (beast) **प्राणी** (living being) are differently understood in different places.

(*ii*) The age entries in the school records do not appear to be reliable. Parents pretty often give wrong dates, sometimes due to lack of time sense and sometimes for other reasons, *e. g.* to ensure that their wards do not get overage for certain openings by the time they finish their education. But accurate measurement of intelligence is not possible unless the age is known correct to a month. Very often the age as given in the school records was obviously lower than what one would judge from appearance or psychological symptoms. It shows, however, that the I. Q. thus found out may possibly be lower but could not be higher. Those found to be superior or very superior, had their age entries carefully verified and as most of them come from cultured families the entries were found to be reliable.

Including those examined last year the total number of children examined totals 2117 (including about 200 girls). As children of both sexes have been examined over a fairly wide area in cities, villages, in the East and West of the U. P. Rajputana, towns, and and C. P.—it may be possible to get a fair idea of the distribution of intelligence in North India.

The figures worked out are as follows :—

	Total No.	P. C.	P. C in America
1. Near genius I. Q. 140 150	4	.2	.55
2. Very Superior I.Q 120-140	54	2 5	2 8
3. Superior I Q. 110 120	116	5 5	9.0
4. Normal I.Q. 90 110	913	43.1	40.0
5. Near Normal I.Q. 80-90	567	26.8	28 6
6. Mentally deficient I. Q. below 80	436	20.5	26.3

It may be noted that the Simplex Tests are far more searching than Terman's and the figures for American children are based on Terman's tests. Indian children show better results when given the latter tests.

PSYCHOLOGICAL METHODS OF MEASURING INTELLIGENCE

No child has been estimated to have an I. Q. of more than 145. If the tests are reliable, it follows that the country is poor in geniuses and near geniuses. On the other hand the proportion of mentally deficient is also lower. But at the same time it must be borne in mind that children from backward classes have not been examined so far and we have not been able to examine children in many schools which attract bright children. The figures obtained by examining children in T. N. Schools for boys and girls show that the atmosphere of kindness and freedom acts as a magnet in drawing out all that is best in boys and girls Out of 114 boys and girls examined as many as 19 were found to be superior, which gives a percentage of 16.7 as against the general average of 8. 2. The pick of the student community prefers to go to Government Schools or those with good reputation. Unfortunately very few Government Schools have co-operated with us so far.

Of the 4 + 54 children in the near genius and very superior groups, an overwhelming majority come from literary castes *e. g.* Brahmins, Kayasthas, and Vaishyas though other communities are not unrepresented. Then again families which have *migrated from other parts* are responsible for a disproportionately large number of bright children *e. g.* Bengalis, Kashmiris, Punjabis, and Maharastra, Telegu, Tamil and Gujrati Brahmins and so on. The only explanation which can be given is that families which have migrated are more pushing than stay at home people, hence heredity is in favour of their children. Another interesting phenomenon noticed was that even in the cases of children belonging to very intelligent communities, the I. Q. of children coming from families where drink, *bhang* or sexual vices have got a foothold, was comparatively lower.

The conclusion based on these tests are provisional only and will need modification in the light of reports, which have not come, but are expected, and in the light of further tests which will be made before long.

A discouraging phenomenon which was noticed is that Indian children are slow to react to responses. The modified tests were based on Simplex, only because it was necessary to compare the amount of mental work which the British children can do in a given time as compared to Indian children. The Simplex Tests have been found to give sufficient work to British children for an hour and a half. Most of the pupils examined here, however, complained of the inadequacy of the time given. But it was also noticed that they frittered away a few minutes here and a few minutes there. It is possible that some of the children would have secured a higher I. Q. had they been given a little more time. But a quick and correct response, without waste of time is also an element of intellectual fitness.

The highest I.Q. reached so far is 145 scored by a Bengali Kayastha boy, whose school record shows that his worth is not appreciated in the class room.

What is true in the case of this boy is also true of other gifted children. Only in a few cases do the school-records give any hint of the high capacity which lies latent in them, though on the whole they do not do badly in the class room. From my observations of many of these children, I can say that they are social, cheerful and fond of raising knotty and troublesome questions in the class room. Their health does not seem to be inferior to that of other boys. There does not seem to be much ground for thinking that precocity leads to poor health.

Quite a large number of school boys above the average age of the class were found to be either of normal intelligence or below normal, and none was found to be above normal. Overaged students are of two types. Those who have become overaged because of retardation in the lower classes and secondly those who began their studies late. It is not difficult to understand why the boys of the first type proved to be inferior. The inferiority of the second type of boys is probably due to mental atrophy for want of suitable stimulus in early years.

The large proportion of inferior children as noticed in the preceding paragraph is probably due to the fact that their language training has been defective and they could not fully understand the meanings of the question put to them. Also because quickness of action in response to a stimulus is not the characteristic of Indian children.

Very few children from class third and fourth attempted to answer the tests, probably on account of the first reason given in the preceding paragraph; but 36 children attempted the tests. As many of them as 17 were found to have either normal or supernormal I. Q. This shows that the tests are not suitable for children in these classes; but on account of the early introduction of English and consequent neglect of Hindi, the linguistic training is deficient and they cannot attempt the tests.

Summary

The provisional inferences which can be deduced so far are that it is possible to have standardized tests in Hindi, the age entries in schools need careful scrutiny, the early introduction of the study of English is prejudicial to the intellectual development of pupils, that bright children are neither recognized by nor adequately cared for in schools and overaged children need being taught separately and if possible by some thing like a Decrolized method. Lastly superior children are generally found in cultured families, though they do not constitute the monopoly of any one section of the community.

During the year 1935, another set of group tests on the lines of Terman was got ready and about two thousand children have recently been examined. The results are being scrutinized. Evidently they have done much better and the proportion of children of superior types is quite large. It was felt that the tests in the original having been standardized, similar ones in Hindi could be adopted with suitable modifications. But it now appears that Hindi tests need being standardized. Norms are being prepared and certain modifications made in the first tests. An Urdu rendering has also been got ready. Our College is also experimenting with Seaforth's Vocabulary, Language and Foreign language aptitude tests.

Unfortunately very little work in this direction is being done in India. Some of the American missionaries are very keen about it *e. g.* Dr Rice of Allahabad, Reverend Mr. King of Ghaziabad, Reverend Mr E. W. Menzel of Baloda Bazar (Raipur District C. P.), Reverend Mr J. C. Koenig of Birampura and so on. Professor S. Jalota of the D. A. V. College, Lahore has prepared Urdu tests and doing laborious work in preparing norms. Mr Kamat has prepared Marhatti tests, but I have not seen them yet. Mr West tried his tests in Dacca, but it is said that he gave up the work in despair because of the misleading age entries. I am afraid the work at Benares is likely to be wrecked on the same *Inchcape rock*. The laborious task of preparing norms becomes useless when age records are not reliable.

From the limited experience we have gained, it seems that the tests give a fairly reliable index as to the possibilities of a child, though like all other human efforts they may not be perfect. They do not claim to test character, capacity for sustained work or ability to control other men, without which success in life can not be assured. Even these have been tried to be tested in other ways. But the immediate uses of these tests in ordinary school or college work can be summed up as follows :-

1. They can help the head master in deciding questions about double promotion and of promotion to the higher class in cases of students whose record is doubtful.
2. They can be helpful in finding out which of the students from other schools, who seek admission in a new school, are fit for a particular class.
3. Also in finding out which of the students are fit for a University course, which of them are fit for the High School course and so on. Help can then be more ungrudgingly given to the most deserving.

The work in India in this respect is still in the experimental stage and as it develops and more experience is gathered it may be possible to make them more useful.

Atmospherics

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EVERY radio listener, no matter in what part of the globe he is situated, must have had, at one time or other, the pleasure of his radio reception spoiled by interfering noises of various kinds emanating from the loud-speaker of his receiver. Some of these noises may, perhaps, sometimes be traceable to some fault in the receiver ; a damaged grid-leak, too tight a coupling of the high-frequency coils or a run-down battery may not infrequently be one or more of the causes of the many undesirable sounds from the receiver. But it has been the experience of every listener that even with a modern, high-class receiver there are noises which cannot be ascribed to any fault in the receiver. These noises, which are very persistent and which seem to defy every effort to eliminate them by improvement of the design of the receiver, are commonly known as "static". Static, according to the nature of their origin, may be broadly divided into two classes. One class, called "man-made static", is due to disturbances set up by electrical appliances or machineries, which reach the receiver through the supply mains, or by radiations from the mains, through the aerial. The other class, called "atmospherics", are due to natural electrical disturbances in the atmosphere finding their way to the receiver along the aerial. Though this article is mainly concerned with the second type—natural static or atmospherics—yet a few words will not be out of place here regarding the first type—the man-made static.

Man-made Static

The city-dwellers who are surrounded by vast network of electrical circuits and by electrical appliances of all kinds are the worst sufferers from this type of disturbances.

Alternating current mains, motors with sparking brushes, tramcars, electric belts, neon signs, and, in fact, all appliances which employ a make-and-break contact device, are potential sources of man-made static. Unless special precautions are taken, they set up electrical disturbances which travel long distances along the electric supply lines. The only redeeming feature of this type of static is that it does not generally travel long distances over the air. A sparking motor, for instance, will produce a crackling, humming noise in a set operated from the same supply mains as feed the motor, even when the set is situated at a distance of 1 Km ; it will not, however, affect a set at a distance of 50 metres, if this latter is operated from independent battery and is not connected in any way with the supply mains. The surest means of stopping such disturbances is to eliminate the causes which produce them at the source. But this is not always practical. The other alternative method is to employ devices at the receiving end, which prevent the disturbances from reaching the receiver. It is not possible to describe such devices here—they generally consist of suitably disposed condensers and chokes. The B. B. C. Empire Service pamphlet, radio magazines, and radio manufacturers publish from time to time the details regarding such devices. These, if carefully followed, go a long way towards stopping the evils of man-made static.

The other class of static—the atmospherics—are much less or, perhaps, not in the least amenable to human control. A very large amount of study has been made to find out the nature and the origin of the atmospherics. Results of such studies carried out over long periods and in many countries show that the atmospherics are definitely associated with lightning discharges in thunderclouds. The general mechanism of the production of atmospherics is not difficult to understand. The top and the bottom of a thundercloud are charged with opposite kinds of electricity. When the electric tension due to these charges becomes very high, a spark or a discharge passes. The discharge becomes the source of highly damped electrical oscillations or waves. By highly damped we mean that the oscillations do not persist: they die away very quickly after two or three swings or, perhaps, at the end of the first swing, in which case it is called aperiodic oscillation. These short-lived waves travel out in much the same way as the electric waves carrying speech and music spread out from the broadcast transmitter. When they reach the receiver they produce those grinding, hissing noises called atmospherics. The essential difference between these oscillations and those sent out from the broadcast transmitter is that while the latter occur with perfect regularity, have a definite periodicity—that means, in practice, that they can be tuned in or out—and produce what one might call continuous waves, the former occur irregularly, have no fixed periodicity—they cannot be tuned out—and produce separate shocks in the receiver. In fact, in analogy with sound-waves, one might very aptly call the broadcast waves as musical electrical notes and the short-lived, irregular waves due to lightning discharge as electrical noises.

Recent Investigations

Recent investigations have revealed many interesting features of these electric oscillations, produced by lightning. According to the rapidity with which the oscillations occur they may be divided into a high-frequency class and low-frequency class. The former has a frequency of two thousand five hundred to ten thousand per second, and the latter of two hundred and fifty per second. There are also, of course, discharges of aperiodic type—that is, consisting of one swing only—showing only the rise and fall, so that they have no particular frequency. A curious fact about these oscillations is that the high-frequency oscillations travel faster than the low-frequency ones. It is possible to estimate approximately the distance of the origin of the atmospherics from the time separation of the two types of atmospherics as recorded in the receiver. Another interesting fact found is that while some of the atmospherics occur in groups, that is, a number of short-lived oscillations rapidly succeed one another and are grouped together, there are others which occur singly. The former ones produce the characteristic grinding or hissing noise and the latter ones "click" in the loud-speaker. The whole phenomena of atmospherics, though very annoying to the radio listener, present many intriguing problems to the scientific investigator.

A characteristic feature of the occurrence of the atmospherics is that they are more intense and numerous in the night, particularly during its earlier part, than during the day. In the tropics in summer, when thunderstorms are frequent, this phenomenon is very marked. The reception from moderately distant stations which, till a few minutes before sunset, was normal and pleasant, rapidly begins to become marred and spoiled by atmospherics of increasing number and violence, till within a few minutes after sunset reception becomes impossible as speech and music are drowned by terrific grinding noises and clicks. The reason of greater preponderance of atmospherics after sunset is the same as that of better reception of distant stations during the dark hours of night than during day. The upper atmosphere plays a very important part in the propagation of radio waves round the curved surface of the earth. This is due to ionization, that is, production of charged particles by the action of the sun's rays. If the ionization is confined to high levels—100 Km. and above—it helps to guide radio waves over great distance. This is the condition during night, when atmospherics produced by lightning discharges thousands of kilometres away are brought to the receiver by the ionized upper atmosphere. If, however, the ionization reaches low levels, say sixty kilometres and below, then the atmosphere strongly absorbs radio waves. This condition prevails during day-time, when, as has been recently observed at Calcutta and also in the United States and England, the atmosphere at heights of even twenty to thirty kilometres is ionized. At such times atmospherics produced only by local lightning discharges reach the receiver, and the distant ones are absorbed by the atmosphere.

Eliminating the atmospheric noise

It is very often asked why no method has yet been evolved to counteract the evils of the atmospherics. It is argued that if it is possible with the use of suitable filters to cut off very powerful local stations and to receive comparatively weak, distant stations, it ought to be equally possible by some such similar device to stop the electrical disturbances caused by the atmospherics. Unfortunately this is not so; and all attempts made hitherto in this direction have failed to achieve the object. The reason is that a radio station, however powerful, and however closely situated, generates waves of a definite frequency range. The atmospherics, as explained before, have no such definite range of frequencies. The only means of minimizing the effects of atmospherics known till now is to employ very high signal strength and to use short waves. A fortune awaits the man who invents a simple device to eliminate the effects of atmospherics in a broadcast receiver.*

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Uses of High-Voltage Electricity

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During recent years the technology of high voltage production has received a great impetus, mainly because of the manifold applications not only to pure scientific researches but also to industry. A decade ago, a hundred thousand volts of pressure was the maximum at which electricity could be produced and utilized with sufficiently large power output to be economical. But at present the improvement in the design of machinery has been so marvellous, that millions of horse-powers of electrical energy are delivered over long distances at a voltage which would have been unthinkable some years ago. In scientific researches, tremendously high voltages of the order of millions are required, but the power generated (current voltage) is not so large as in electro-technology.

Before going into the details of the subject, it will be advisable to define the scale of voltages, so that high and low voltages can be distinguished from each other. The domestic supply of electricity is generally made at a voltage which varies from 50 to 220 volts in different countries. In India the supply is generally kept 220 volts with direct as well as alternating current system. The latter system (220 volts A. C.) is unsafe for domestic consumption, and the yearly list of electrocution casualties testifies to it. Public opinion in India should muster strength and remove this highly unsafe and objectionable system of electric supply at 220 V.A.C. The commercial supply systems have their power lines at a much higher voltage, which they have to reduce to the voltage suitable for domestic consumption. In the case of A. C. this is effected very efficiently by means of transformers, but in D. C. system the methods of voltage reduction are costly as it necessitates auxiliary apparatus which are not only expensive, but inefficient and inconvenient. The problem of voltage transformation with D. C. has been solved by the introduction of grid controlled thyratrons, but the process is still in the experimental stage. The most usual method of voltage reduction in D. C. is by the three-wire system, in which one wire is kept at ground potential, so that if there is an electrical pressure amounting to 440 volts between the two remaining conductors, each of them is 220 volts above or below the ground potential. Now, in commerce, all these voltages up to 440 volts are called low-voltage, while the range between 440 volts and 10,000 volts as high-voltage. The voltages above 10,000 are known as super-high-voltages. In scientific terminology, however, voltages above 10,000 volts are known as high, while below that it is low-voltage.

The main uses of high-voltage electricity are in (1) power transmission over long distances, (2) testing of electrical appliances used in power transmission, (3) industrial, surgical and therapeutical radiology, and (4) scientific researches.

High Voltage in Power Transmission

Why is it at all necessary to use higher voltages in the transmission of electricity ? It is because some amount of power is always lost on transmission through the conducting wires. This can be illustrated by an example. Suppose we have to electrify an area whose total load is 100 kW. If the transmission is done at 220 volts, the total current that will flow through the conductors from the main generating station to the bus-bars of the distributing centre will be 450 amperes, and at 110 volts it will be 900 amps. While at 10,000 volts, it will be only 10 amperes. The losses that take place in the conductors depend mainly on the current flowing through them, and also on their length and thickness, so that larger the current, more will be the loss in the conductors of the same cross-section. The loss can be reduced by increasing the cross-section of the conductor but it will entail huge expenditure. This loss in the conductors has two aspects. It brings about a drop in voltage equal to ir where r is the total resistance of the lines and this drop reappears as heat equivalent to i^2r watts, which has to be dissipated. If the conductor which does not get heated by 10 amps of electric current flowing through it is used for 450 amperes, it will burn up in a flash like a fuse wire. This is because the heat generated is proportional to square of the current. In the example taken above the line losses in 220 volt supply wires can be made the same as that of the 10,000 volts, if the cross-section of the copper conductor is 45 times greater in the latter system. As this alternative is impracticable, the only method of reducing the conductor losses is by increasing the voltage. The 100 kW supply will be made at 10,000 volts and at the distributing centre it will be stepped down to 220 V again. This transformation is only possible with A. C. system, and that is why supply contractors insist on higher voltage.

In power transmission, in areas where the supply system is not very extensive, voltages of the order of 800 to 3000 volts A. C. are used. This is generally true in the case of town supply where the consumption is large. The conductors are kept underground and at suitable centres the voltage is stepped down to a suitable value for distribution. In rural areas where comparatively large distances separate the consuming centres from the power station, voltages as high as 10 kV to 33 kV are used (1 kV = 1000 volts). In extensive grid schemes such as exist in many countries like England, Germany and America, a still higher electrical pressure is used. The English grid scheme is working at 132 kV and it consists of large number of thermal power stations dotted all over the country and connected with each other. The lines which connect these stations are criss-crossing the whole country and from these lines the power is tapped through sub-stations where the voltage is stepped down and transmitted to consuming centres. These sub-lines are further tapped, and the power reaches the individual consumers at a safe low voltage. The size of these power stations (or the total energy they have to supply to the inter-connected lines) depends on the consumption of the area which it will serve. The excess of power which it produces after satisfying local demands is fed into the grid lines so that it can be transmitted to distant places with minimum of loss.

Then there are other gigantic schemes of power generation where a source of potential energy like natural waterfall is utilized to produce electricity. In such cases the amount of energy available is very large but the distance between the source and the sink of energy becomes so considerable that the transmission voltage has to be raised still higher. In this country there are some hydro-electric developements but they will pale into insignificance before the great Boulder Dam Scheme of southern California, where recently (September last)* President Roosevelt switched on to the lines electrical energy amounting to several hundred thousand kilowatts at a pressure of 220 kV, and electrified a large tract of that country containing rich mining, industrial, and agricultural areas. The great cities of Los Angeles and Hollywood have also been connected to the scheme. This new hydro-electric project is a triumph for modern electro-technology. There is another gigantic scheme afoot and partly in working condition in Soviet Russia. It is the Dniepier Stroy Dam Scheme on the river Dnieper where electricity is generated to feed a rural area comprised in the Republic of Ukraine and the surrounding territories. The voltage at which the transmission is being made is about 380 kV while schemes are in project involving a much higher voltage, *i.e.*, 500 kV.

The existence of coal bed in a country should not be an argument for neglecting its water-power resources. It is true that England and Belgium, having no water-power, supply electricity at a lower cost than, say, Japan or Norway where the large bulk of electrical power is hydro-electrically generated. A simple argument will convince us of the necessity of hydro-electric generation wherever they are possible. The coal deposits are limited in extent, and at the rapid rate of consumption it is not probable that they will last long. A noted geologist in England estimated that at the rate of consumption that existed in 1900, the total quantity of coal will not last 500 years. Since 1900, the consumption of coal is mounting up everywhere, and in coming decades it will rise further. The result will be that coal will become scarce within two or three generations. The hydro-electric systems are bound up intimately with the destiny of man, of *homo sapiens* or 'man the wise' as he, in his stupendous vanity, calls himself. As has been pointed out by Mr H. G. Wells, a more appropriate title for human species ought to be *homo stultus* or 'man the fool' because of the way he is eating up and burning up his means of subsistence and reserves.

A Grid system for India

In India the problem of super-high voltage supply on a grid scheme is still to come. The largest areas where electrical energy is consumed are the cities of Calcutta and Bombay. The Calcutta Electric Supply is controlled by the Calcutta Electric Supply Corporation. This firm manufactures electricity from coal and has a totalled installed capacity of 80,000 kilowatts. Other cities in Bengal and Eastern India manufacture their electricity from coal on a smaller scale. As was pointed out in SCIENCE & CULTURE some time ago, most of these companies charge prices of electricity which are out of all proportions to the manufacturing charges and thus make enormous profits for themselves. A far better plan would be to work out a grid system for the whole of eastern India. This would consist of a number of super-stations of coal-mining areas like Jherriah and Asansol, manufacturing electricity out of coal and distributing them at a pressure of 100 to 200 thousand volts over the whole of Bengal, Bihar, and Orissa. A scheme like this will not only make electricity cheap but lead to great industrial improvement and efficiency. In other parts of India where coal is not available but grid systems operating on hydro-electric power resources may be devised.

The most important property of electricity at high voltage is its tendency to break through any insulation which separates the charged conductor from another conductor charged to a lower potential. Hence the development of these methods of power transmissions took place when the problem of insulation was thoroughly understood and worked upon through researches lasting for decades. This will be dealt in a later part of the article.

Surges

As long-distance power transmission was gaining ground, it was found that the power lines as well as the machinery were subject to a large number of disturbances of electrical nature which were not only detrimental to the life of the apparatus but in many cases proved fatal for them involving a financial loss to the producer, inconvenience to the public and industrialists because of the failure of supply. These disturbances go by the name of 'transients' or 'surges' and owe their origin to the storage of electrical energy that takes in capacitive and inductive circuits primarily and secondly outside the system of conductors used in the transmission, *i.e.*, in the atmosphere. This latter phenomenon is generally known as atmospheric electricity, and its causes are meteorological. Suppose that a highly charged cloud-bank passes over a conductor carrying current at a high voltage. The cloud will induce electricity on the conductor, but as soon as the cloud-bank passes over, the induced charge will be set free and it will raise the potential of that point on the conductor to an extent which added to the high potential already existing there can easily break through any weak point in the insulating pillars on which the conductors have been mounted. This extra-high potential may be several times the voltage of the line, and as the insulation used is generally meant for withstanding the voltage of the line, the high potential thus developed breaks through the insulation. If the insulation of the line to ground is sufficient to withstand this pressure, the potential travels like a wave along the conductors and enters the generating and distributing machinery. The insulation inside these machines is much feebler compared to those outside between line and earth, and consequently the machines are damaged and stop working. Fortunately, this abnormal potential rise is momentary, as the very name 'transients' suggests and its duration depends on the amount of induced charge as well as on the electrical constants of the line and the machines. A similar transient phenomenon takes place during actual lightning strokes on the line. The other kind of momentary surge is due to the inductive or capacitative action of the conductors carrying currents. These do not matter much so long as a steady current is flowing, but when some switch which controls a large current is closed in or out, the energy stored in the two actions referred to above give rise to a voltage surge, and its action is injurious to the system. Many methods have been devised to counteract these surges but it is found that the life of an insulator under the influence of the surges depends upon the composition of the material and its physical and chemical conditions. It became necessary to test these insulators under conditions which are identical with those they will actually encounter during service. It was known that the failure of insulation does not depend on the extent of the high potential, but on its rapidity of rise and duration. The insulator which is sent out by the manufacturer for sale, is first tested to withstand a steady electrical pressure which may be twice or thrice as great as the potential to which it will be subjected to in actual service. It is also subjected to an artificially created surge whose rapidity of rise and duration can be controlled. The mechanism which creates this very high potential is known as a surge generator, in which some condensers are charged in parallel and discharged in series. Most of the important manufacturers of insulators, cables etc have these surge generators which can produce three to four million volts' pressure lasting for hundredth of a second. The rate of rise of voltage can be adjusted so as to imitate the conditions existing in a lightning discharge. In a lightning discharge the total potential stress applied to the insulators may be hundred times as great as these surge generators, but as has been emphasized, it is not the value of the potential that matters so much as its rate of increase. The rate of increase of the potential in the case of surge generators can be adjusted to be the same as in lightning discharge, after this test the faulty insulators are rejected.

X-ray in Medicine

The high voltage apparatus used in power transmission were being developed side by side with those used in another important application *i.e.* radiology. The great discovery of X-rays was made in 1895 by W. C. Röntgen, and soon after that it found useful application in surgery. X-rays were proved to be radiations coming out from the target within the X-ray tube. The target is bombarded with electrons which exist in the rarefied gas in the tube, and the necessary acceleration of the electrons is provided by a high potential source applied between the target and another electrode called the cathode. So that a source of high potential is necessary for producing X-rays. For two decades since the discovery of X-rays, the methods of production of these rays were crude, primarily for the fact that X-ray tubes were inefficient.

The intensity of X-rays of a certain penetrating power depends only on the amount of electric current that is passing through the tube, while the penetrating power itself depends only on the voltage which has been applied to the electrode of the X-ray tube. Now, in the older kind of gas-filled tubes, in which the electric current was due to the ionization of the residual gas, the number of ions or the carriers of the current was small, so that it was impossible to generate intense X-rays with such tubes. It was in 1913 that Dr W. D. Coolidge working in the Research Department of General Electric Company of America produced a new type of X-ray tube in which the carriers of electricity were not derived from the residual gas but from another source. This source was a white-hot filament of tungsten. The amount of electricity which can be obtained from this filament depends upon its temperature and dimensions. Before the advent of these tubes (known as electron tubes or Coolidge tubes) the usual method of producing high potential for running them was from small induction coils of low power output, but fairly high voltage output. In order to work with X-ray tubes consuming large power and giving very intense X-rays, these induction coils were soon replaced by transformers. The lead in this direction was taken in America where the Coolidge tube was designed and perfected. At present transformer outfits are usual everywhere in X-ray technique.

It was recognized very early that hard X-rays have strong therapeutical properties, and have distinct healing action on cancerous growths, tumours, and other affectations of human body. The practice of medico-surgical radiology can be divided into three parts: (*a*) Radiography, (*b*) Fluoroscopy, (*c*) Therapy—superficial and deep.

Radiography

Radiography consists in taking shadow photograph of any part of human body. Such a photograph is called a radiogram or skiagram, in which the denser components of the exposed part of the body absorb more X-rays than the softer parts. The result is that these opacities throw a shadow on the photographic plate. In this way the occurrence of fracture of bones, malformation of organs and bones, deposit of tubercle and calcarea, intrusion of foreign bodies, can be found out. The localization of fractures and foreign bodies comes under surgical radiology, while the examination of organs and tubercular deposits forms part of diagnosis. But both these involve the penetrating power of X-rays which, on the other hand, depends on the voltage applied to the X-ray tube. The range of voltage used varies from 50 kV to 80 kV for different operations. The higher voltages are used when thicker parts of the body are examined. But conditions vary so much that a hard and fast rule cannot be given in an article like this. The intensity of X-rays is so adjusted that it gives good contrast on the photographic film of certain sensibility within a time which is small enough not to injure the tissues. The practice of diagnosis is more difficult because the radiologist has to find difference in the structure of an organ which has almost the same opacity for X-rays as its surrounding matter. It requires a good deal of experience and judgment to take a diagnosis radiogram, and more so in interpreting it. But the science of radiology has advanced so much that very reliable information can be obtained with ease.

In fluoroscopy, instead of taking a photograph, the shadow is thrown on a fluorescent screen made of barium platinocyanide salt deposited on it. This salt begins to glow with greenish light as soon as X-rays fall upon it. The fluorescent image is examined visually. In this arrangement, the penetrating power of the X-rays is much less than in the case of radiography. This is due to the fact that X-rays of great penetrating power cannot make the screen fluoresce well. On the other hand the intensity of X-rays is kept much larger because visual examination demands it. The voltage used varies between 40 and 70 kV.

X-ray Therapy

Lastly, we come to the method of therapy in which feeble X-rays of great penetrating power are applied to some affected part of the human body. Very high voltages are used with this application of X-rays.

The dose of X-rays which is administered to the body is measured accurately, and hence the quality of X-rays must be uniform and repeatable; otherwise one cannot be sure of the results. In therapy, voltages of the order of 100 kV to 220 kV are used for different cases. It requires a very large amount of experimental work for making apparatus which would produce such high voltage, and at the same time be within the reach of medical practitioners' purse and space. The devices with which these high voltages are produced from apparatus meant for working at a low voltage are very ingenious, but they cannot be described here. Up till 1924, 220 kV X-ray high-tension generators were the highest achievements in the domain of radiology. The trouble was not so much in generators as in X-ray tubes. At such high voltages the usual phenomenon of brush discharge, ionization within the dielectric, begins to take place and vitiate the results.

Just as hard X-rays have therapeutical properties in certain organic ailments, the γ-rays from radium which are not very different from the former rays have long been used for that purpose. But radium is so costly that a widespread experimentation in radium-therapy was out of the question. For a number of years, certain workers in this field were attempting to construct an X-ray tube which would produce rays of the same penetrating power as that of γ-rays from radium. In that case, the use of expensive radium can be eliminated, and also there will be an added advantage in our ability to vary the penetrating power of the rays to any extent, while in the case of radium the penetrability is fixed. The most successful experiment is that of W. D. Coolidge who in 1926 constructed an X-ray tube of special design and working on 500 kV. This X-ray tube is now in the possession of Chicago Cancer Research Institute. Coolidge further extended the range of voltage to 800 kV and then to one million volts (1000 kV).

Side by side with these improvements in medico-radiological practice, another development was taking place in the industrial application of X-rays. X-rays of sufficient penetrating power (excited by 150 to 400 kV) were being used in radiography of metal castings, forgings, and machinings. The fractures, blow holes, and other flaws, which cause the failure of the metal parts while on service, can be easily detected by X-ray methods. The voltage range was gradually pushed up, till many works have X-ray tubes and auxiliary apparatus working at one million volts.

High Voltage in Nuclear Research

The method of producing ultra-hard X-rays to replace radium in cancer treatment stimulated research in still another direction, and this fell in the domain of scientific researches on the structure of the nucleus. It is well known that Rutherford and his colleagues bombarded atoms with α-particles from radium; and from the scattering of these particles by the atomic nucleus, he obtained some very interesting results about its structure. Much of our knowledge of the interior of the nucleus is derived from these experiments. The number of α-particles which were used were small because radio-active substances are costly and their rate of emission of α-particles is small. When Coolidge's experiments on the production of X-rays of great penetrating power, approaching those of the γ-rays from radium, were successful, it occurred to many workers to produce high-speed protons (or positively charged particles) in the same way. In Coolidge's experiments electrons were given high speed, but now it was the turn of the proton. It will be out of place to describe these here, but we can recount some of the difficulties encountered. The main problem was of constructing a discharge tube which would be able to bear such a huge electric stress, but it was solved in the manner first suggested by Coolidge. Breit and Truve of Carnegie Institution of Washington developed in 1930 a source of high potential of 3 to 4 million vo'ts, and succeeded in increasing it to a much higher value. But the main defect with their arrangement was that the potential was alternating at a very high frequency. It was found that the method was not suitable for producing high-speed particles.

In the mean time, Cockroft and Walton of Cavendish Laboratory, England, constructed generators utilizing the principle of voltage multiplication as in deep therapy, but in a modified form, and succeeded in producing steady high voltages as high as 800,000 volts. This was a distinct achievement in the field of high voltage production, and the results of their experiments have since become classic. They generated protons from special type of discharge tube and allowed them to be accelerated by the applied potential. When they had acquired sufficient velocity they impinged on a target on which some light elements like beryllium or lithium were put. The high-speed protons caused the nuclei of the atoms to break up or disintegrate. The products of disintegration were experimented upon and from the results immense light was thrown on the structure of the nucleus. Recently Sir Herbert Austin, the famous automobile magnate, has donated a princely sum of £250,000 for building a high Voltage Laboratory at Cambridge under the supervision of Lord Rutherford. The next few years will see the development of high-voltage research to an extent never realized before. But American workers were still bent upon increasing the range of high voltage. It has been said that the limit of low-frequency high voltage was about a million volts and above that only high-frequency high voltage can be generated. But the high-frequency high voltage was unsuitable for work with speeding up of charged particles as the experiments of Breit and Tuve proved.

Cockroft and Walton had produced steady high voltage but it was below a million. It became apparent that with electro-magnetic apparatus it was not possible to produce steady voltage higher than a million. Two different ideas cropped up from two ingenious workers. One was Prof. E.O. Lawrence of America who proposed to produce high-speed particles without high voltage at all. The other was from Van de graaf of Massachussetts Institute of Technology, who utilized the electro-static induction machine.

In E. O. Lawrence's experiments a charged particle is successively given an impulse amounting to several thousand volts each time, and after a number of such impulses the kinetic energy of the particle became very large. When it arrived at its destination, its velocity was such as if it had accelerated in a field of the value equal to the number of impulses time the applied potential. It is clear that the path of the charged particle will be very large. In his former experiments, he used a straight path, but then he caused the particles to move along spiral by means of magnetic field. When these particles arrived at the periphery of the spiral, its velocity corresponded to a potential fall of several million volts. With this apparatus he succeeded in confirming the results of Cockroft and Walton.

Van de graaf in 1931 constructed a small electrostatic generator, in which a broad paper belt was moved rapidly over two pulleys one of which was on the ground and connected to the shaft of a high-speed electric motor, and the other pulley was mounted high above the ground inside a hollow aluminium sphere insulated from the ground. The paper belt passed through the sphere through apertures made for them. As the belt moved rapidly over the lower pulley, it was charged up, and the charge was carried up to the insulated sphere. In the original apparatus he succeeded in producing 3 to 4 million volts of pressure between the ground and the sphere.

A great deal of experimental difficulty was encountered in erecting this high-voltage plant, and in its present form it is very far from its original. But the experience gained was unique, and it was utilized by Tuve of Carnegie Institute of Washington in atom-disintegrating experiments. The charge at high potential developed in these electro-static generators can be stored only on the surface of the aluminium spheres, which act like condensers. A large amount of the charge leaks away into the air in the form of corona discharge. The aluminium spheres used by Van de graaf were about 10 ft in diameter, and it was proposed to instal a laboratory fitted with generators for power within the sphere. The power would be derived from the moving belt. There will be two such spheres at some distance away from each other and they will be charged to opposite potentials. The discharged tube will be connected between them. Such a scheme is in the process of building up at Round Hill near Boston under the auspices of Massachussetts Institute of Technology. It may produce something between 15 to 20 million volts. Tuve generator was on a laboratory scale, and he extended Cockroft and Walton's work much further.

High-voltage phenomenon is not only interesting but also fascinating. Human agency has succeeded in producing artificial lightning which will jump over a gap of 50 ft. But human ingenuity is far behind the electric potential which nature carelessly produces in the skies.

It has been estimated by careful workers that potential difference developed between the cloud-banks at the time of discharge may be as high as 100 million volts, while in the case of cloud to earth discharge it might be many times more. Two daring workers, Brasche and Lange, in Germany attempted to use these high-voltages generated in the sky for laboratory experiments. They stretched a cable between two high hill-tops in Alpine regions where thunder-storms are very frequent. The cable was insulated from the supports by means of heavy porcelain pieces each of which weighed 10 tons. The laboratory was situated in the valley below, and a conductor led from the cable to the laboratory. They found that very high potentials could be obtained by these means.

Rural Survey in Travancore

Navendu Dutta Majumder

In December, 1932, an association for rural reconstruction named "Jana-Seva Mandali" was formed in Calcutta on the initiative of Mr Hemendra Nath Datta with Mr Ramananda Chatterjee as Secretary. My services were requisitioned by this association, and in connection with this work, myself with two colleages, Messrs J. Nandy Majumder and S. N. Datta, proceeded to the rural development centre at Martandhum in Travancore State in March, 1933. This centre is under the Y.M.C.A., and Dr Spencer Hatch is in charge of the organization. At that time a short, one month's training course was being held there, and students came from all provinces of India to join the course. There were also four Americans, one Englishman, and one Dane in the training camp. The course consisted of theoretical and practical lessons in various subjects, such as rural sanitation, rural education, poultry-farming, bee-keeping, rural survey, etc.

While at Martandam, I undertook surveys of two villages—one a health and sanitation survey of Maruthankode and the other a general village survey of Kannankode. In the first survey, there were in my group two ladies, one Marathi and one American, and two gentlemen, one local and one Danish. In the second, I had with me three gentlemen, one from the U. P., one local, and one Danish. I take this opportunity of acknowledging my gratefulness to all my colleagues and the villagers for their hearty co-operation with me. A summary of the two surveys is given below.

Maruthankode is a small village, two and a half miles to the north-west of Martandam, situated on rocky and sandy hills which are off-shoots of the Western Ghats. The houses are mostly detached, one-storied, and built of mud and "cadjan". Cadjan means cocoanut leaves ; these are woven together and then used.

From the sanitary point of view, the houses of the poor are better than those of the well-to-do. For the latter, though in a good condition, are constructed in such a fashion as to banish light and air. Some five or six rooms are haphazardly built without any properly placed window, and they look like veritable dungeons. A poor man's house presents quite a different picture, a miserable thatch with broken mud walls and big gaps between the roof and the walls, which admit light and air. In most of the houses there are palmyra, cocoanut, mango, and jack fruit trees in the compounds and the surrounding places. Rubbish and kitchen refuse are generally scattered all over the compounds. There is no systematic arrangement for using them as manure. Drains are conspicuous by their absence. There is no latrine system in the village. In only one house did we find a bore-hole latrine. It is a habit with the people there, irrespective of age and sex, to go into the near-by jungles for the purpose.

The villagers obtain their water-supply mainly from wells, dug and built. Very often there are parapet walls, about 2 ft high and built of bricks and stones. In the winter, the depth of water varies from 15 ft to 20 ft, but in the summer, most of the wells go dry, and the villagers dig water out of tanks or springs.

During our health and sanitation survey, we made some enquiries as to the economic condition of the people. The majority of the village-folk are very poor, whole families consisting of five members depending upon five annas a day, sometimes less, for dragging on their existence. Many of them are palmyra-climbers, a separate caste by themselves. Palmyra-climbing is an arduous work ; for the men have each to climb 40 trees, all about 60 ft high, twice daily. I did not find a single adult palmyra-climber who had not a thick, round corn in the middle portion of his chest, which was the result of constant friction with the trees. The worst victims of poverty seem to be the Christians. One Christian palmyra-climber has a family of five members and his monthly income is only Rs. 5/-. Very few of the Christians possess lands ; some of them are catechists.

The palmyra-climbers belong to a widely distributed tribe, called Izhuvans or Illavans, inhabiting Malabar, Cochin, and Travancore. They are known in North Malabar as Tiyyans, and in Cochin and Travancore as Chovans or Izhuvans. From the etymological meaning of the words "Izhuvan" and "Tiyyan" it can be inferred that they are immigrants from Ceylon. The word 'Tiyyan', another form of 'Dweepan', means an islander, and 'Izhuvan' signifies one who belongs to Izham, an old name for Ceylon. They are divided into several subdivisions or subcastes. Broadly speaking, there are three subcastes, namely, Tiyya Chone, (Chovan) Pandy Chone, and Velakandi Chone, in Cochin, and two, namely, Nadi Chone and Pachilli Chone, in Travancore. They are also divided into *Illams* and *Kiriyams* (family groups) which correspond to the Brahmanic *gotrams*.

Among the Izhuvans, in former times, intermarriage between members of the same locality was the rule, any violation of which was visited with social excommunication. There has been, however, of late a tendency towards violation of this rule. Exogamy is observed with reference to the *illam* or *kiriyam*. Cross cousin marriage or marriage with the daughter of mother's brother is regarded as the best form of marriage. A man has the liberty to marry more than one woman, but the practice is seldom resorted to. Adultery is looked down upon and very rare among the Izhuvans. There is provision for divorce or *Aarharam Kodukkal*. A partnership may be dissolved either by mutual consent or at the will of the spouse in the following cases, namely, want of mutual affection between husband and wife, infidelity on the part of the husband or the wife, impotence, barrenness, levity of conduct, insanity, and other like causes.

Izhuvans profess Hinduism. The influence of the cult of Shiva is greater upon them than that of Vishnu. Animism also plays a not wholly negligible part. But Christianity is gradually making progress among the poorer sections. Ancestor-worship is prevalent among them. The dead ancestor is supposed to become a deified spirit after the performance of funeral rites and to protect the members of the family. Neglect in the performance of the regular rites is supposed to turn the departed spirit into a *pishacha* or foul, wandering spirit, disposed to take revenge on the members of the family. An indication of the custom of serpent-worship is found in the fact that there is a serpent grove in the south-west corner of the compound of the house of every member of the caste, and that any disrespect towards these shrines is believed to cause the serpents te exercise an evil influence.

From very early times, the occupation of the Izhuvans consisted in the rearing and cultivation of cocoanut and palmyra palms, toddy-drawing, and arrack-distilling. They also manufacture coarse sugar (jaggery) from toddy.*

From the foregoing survey, it will be evident that there are two distinct classes of villagers—the rich and the poor. The former are in immediate and urgent need of being educated in per-

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*The social facts regarding the palmyra-climbers have been taken from *The Cochin Tribes and Castes* Vol. I, by Dr L. K. Anantha Krishna Iyer.

sonal and public hygiene. But what the poor stand most in need of is primarily the betterment of their economic condition. A reasonable standard of living must be brought within their reach and all efforts should be directed to that purpose.

Kannankode is a village about one mile to the north-east of Martandam. We surveyed 25 houses of the village. Of them 10 are Hindu and 15 Christian houses. The total population of all the houses is 129, including 36 adult males, 30 adult females, 32 boys, and 31 girls. The average number of members per family is 5. It is to be noted that the number of females is less than that of males in the village.

Nineteen houses are detached and only six continuous. The condition of 4 houses (belonging to four Nayar Hindu families) is good, of 19 fair, and of 2 very bad (practically unfit for human habitation). Mud, cadjan, sun-dried bricks and tiles are the materials used in building houses. The choice of the materials is dependent upon economic capacity. Even in well-to-do houses light and ventilation is poor, and that is due to the defective construction of buildings. There are no latrines. The villagers obtain their water-supply from wells, tanks, and rivers.

Elementary education is encouraged by the State Government. The number of literate adult males is 21, and that of femals 12; of 27 children of school-going age, 21 are in school. The percentage of literacy is 64.3, much higher than the standard of any Bengal village.

Coming to occupation, we find that 19 are farmers, 1 teacher, 2 palmyra-climbers, 1 mason, 2 coolies, and 2 businessmen. Eighty per cent of the people depend upon agriculture, and 20 per cent on manual labour alone, unaided by land. The average annual income per family is Rs 154-1a only.

The only cottage industry we found there was jaggery-making, and that too in only five families. The average annual net profit per family from this source is Rs 11/- only. Tapioca, paddy, palmyra, cocoanut, jack, laurel, tamarind, and plantain trees are among the crops which constitute subsidiary sources of income. The average total profit from crops per family per year is Rs 50/-. They do not cultivate any kitchen or flour garden.

The farmers are all peasant proprietors. Unlike in other parts of India, specially Bengal, landed middle-men are absent here. Twentyfour and half acres of land are dry and 5 acres wet. The percentage of wet land is only 20. This is one of the main reasons why Kannankode is comparatively free from the evils of malaria and hookworm.

Only 9 houses have got poultry yards. There are 12 pure-bred and 21 country fowls. Three houses sell their eggs through the Martandam Y.M.C.A. Co-operative Sales Society, and two through the local market. Four houses consume their eggs. There are no sanitary poultry houses, and the people are not keen on increasing their stock.

The cattle present a horrible picture. Their condition is as bad as it can possibly be. Fourteen houses together possess 6 bulls, 15 cows, 8 calves, and 4 buffaloes. The average price of a bull is Rs 18/-, of a cow Rs 13/-, of a calf Rs 6/-, and of a buffalo Rs 16/-. The average period of the calving of a cow is 1½ years. In all cases, milk is consumed and not sold. Straw and grass are given as fodder in all the houses, 6 houses give bran, and only 1 house gives oil-cakes also. Three-fourths of an anna is the average cost per cow per day. No special fodder is raised. Farmyard manure is kept in open space and afterwards used in fields. Cattle are housed in thatched monsoon sheds.

Seven houses have got 12 goats, all country-bred. The average price of a goat is Rs 3/8/-. Grass, green leaves and oil-cakes are given as food. The average cost of keeping a goat per day is ½ anna. There are no separate sheds for goats; they are kept along with the cattle.

The average household purchase per family per year on account of agricultural implements, clothes, betel, tobacco, seeds, furniture, etc., amounts to Rs 19/-. The cost of food is not included in the above. Thirteen houses hire coolies for cultivation, and on an average each house spends Rs. 19/- per year on this account. The average annual expenditure per faimily on charities (including religious rites) is Rs 4/-.

Sixteen houses are indebted to the extent of Rs 3,227/-. Three houses have lent money to the extent of Rs 700/-. The average amount of indebtedness per family is Rs 201/11/-. In one house we found the rate of interest to be 12 per cent.

No family has any bank account. Four houses have total saving of Rs 1,842/- in the form of paddy. Twentyone houses possess jewellery worth Rs 2,315/-. The average value of jewellery per family is Rs 110/4/-.

Seventeen houses have to pay an annual doctor's bill of Rs 71/8/-. The average per family is Rs 4/4/-.

The above account of some villages of Travancore State is given in order to indicate in outline the living conditions there and it is hoped that similar surveys with details may be carried out with groups of villages in other parts of India to get a grasp of the actual conditions.

Indian Science Congress, Hyderabad

THE 24th session of the Indian Science Congress was held this year in the city of Hyderabad (Deccan) from the 2nd to the 8th of January and was a great success from every point of view, thanks to the hospitality of the Osmania University and of H. E. H. the Nizam's Government. The local secretaries, members of the local committee, and the volunteers are to be congratulated on the efficient manner in which they carried out their arduous, self-imposed tasks.

The number of delegates was about 400, and they came from all parts of India. They were comfortably lodged in the two magnificent hostels of the Osmania University aud the sectional meetings were held at the temporary College buildings of the University. The presidential address and popular evening lectures were delivered at the Town Hall, with a view to provide an opportunity to the general public to attend. Elaborate and free conveyance arrangements were made with motor buses and cars for carrying the delegates from the hostels to the sectional meetings, popular lectures, excursions to various places of interests in the State, and to and from the station.

Owing to the unavoidable absence of H. H. the Prince of Berar who was to open the session, the proceedings of the Conference were opened by Sir Akbar Hydari, who before delivering his inaugural address read out a message from H. E. H. the Nizam welcoming the delegates to his capital. In the course of his speech, Sir Akbar said that by a happy chance the 24th session of the Indian Science Congress at Hyderabad happened to coincide with the Silver Jubilee year of the Nizam's reign, and he hoped that the delegates who had assembled at Hyderabad from all parts of India would be able to notice what all-round progress the State had made under the present Nizam. The Osmania University bore testimony to the great intent of H. E. H. the Nizam in the educational and cultural uplift of the people. The decision to adopt Hindusthani as the medium of instruction in the Osmania University was a great step forward in the direction of national unity and synthesis. "That decision is the corner stone of our educational policy and fortified by experience stands more irrevocable today than it did in any previous time" The delegates were welcomed in a suitable speech by Nawab Mehdi Yar Jang, Vice-Chancellor of the Osmania University and Minister of Education of the Nizam's dominion.

The daily programme during the session was fixed as usual: sectional meetings in the morning, excursions in the afternoon, and parties and popular lectures in the evening.

We have already published the speech of Dr Venkataraman, the Congress President, who is well known throughout India for his work on Plant genetics and for the breeding of the various new types of sugarcane plants which are known throughout India as Coimbatore varieties and which have made the sugar industry possible in India. A part of Dr Venkataraman's address, which was not included in our previous publication, dealt with his work on the breeding of new varieties of sugarcane. We hope to publish an account of this work in the near future.

A welcome feature of the programme, which is comparatively recent but is growing very popular, was a number of discussions on a number of important and highly interesting scientific topics. The following discussions took place: *(a)* Wegener's theory of Continental drift applied to India, *(b)* Nutrition, *(c)* Soil survey of India, *(d)* Age of the Deccan Trap, *(e)* Conditioned Reflexes, *(f)* Glycosuria. Some of these discussions were highly successful and important from even a purely scientific point of view. The one on the Wegener's theory was able to attract one valuable paper from Dr Seymour Sewell, containing an account of the original findings of the expedition under him in the Arabian Sea.

The state of Hyderabad contains a number of places of great archaeological interest like Ajanta, Ellora, Warangal, Daulatabad; excursions were arranged to these places and many delegates took this opportunity of visiting these places. Trips were also arranged to Bidar, ancient capital of the Bahmanis who ruled this part of southern India from 1337-1518 A. D., to the ancient castle of Golconda which is on the outskirts of Hyderabad, and to Nizamsagar, a large artificial lake of about 100 sq. miles formed by blocking a river.

After the conclusion of the session, a number of delegates made a trip to Ellora and Ajanta, the world famous caves, on their way back. Both these caves were reached by long motor journeys from Aurangabad. Mr Hafiz, the Tehsildar of Aurangabad, rendered great help to the delegates and made all the arrangements for conveyance, boarding and lodging, etc. Thanks to the hospitality of the curators of the Ajanta and the Ellora caves, and the tehsildar, the excursion was very successful and thoroughly enjoyable.

Notes and News

Veterinary Research at Muktesar

What must be considered as one of the most important advances yet made in the campaign against India's livestock diseases took place during the year as a result of many years of intensive work on the rinderpest virus.

The Director, Imperial Veterinary Research Institute at Muktesar, in his report on the Institute for the year 1935-36 refers in particular to the success achieved in making a vaccine from the spleen infected artificially with rinderpest, and points out that although its adoption will reduce and, in the end, eliminate any revenue from the scale of anti-rinderpest sera, it is a most valuable discovery for the protection of the ryot in India, being a remedy which is both cheap and permanent. The method of vaccination known as goat virus alone, using either spleen or blood, will give lasting immunity against rinderpest—the most dreaded cattle plague in India—with the minimum amount of trouble and expense.

As much time as could be spared was devoted to the diseases of poultry, the matter being now of considerable importance, as the improvement of poultry figures largely in rural development work. As a result of the investigations at the Institute, considerable advance has been made in knowledge in regard to the incidence of fowl pox, and the efficient vaccine is now available for the control of this disease. The search for a similar agent for use against the more dreaded complaint, Doyle's (Ranikhet) disease, however, still eludes every worker, but as a result of work done in the Serology Section last year there is some slight hope that success is not so remote as it previously was. It may be hoped that efforts in this direction will be intensified, as soon as the Poultry Research Section of the Institute is functioning.

Studies were continued on Bovine Haematuria (passage of blood with the urine). The reported finding of an Entamoeba as the causative organism has not yet been confirmed by other workers. The cause of the disease, therefore, still remains undetermined.

The finding of worm larvae in the lachrymal gland of a horse suffering from what is called "Periodic Opthalmia" in certain parts of the Punjab was reported by the Serology Section in last year's report. As a result of more intensive work during the year under review, the constant presence of micro-filaria in the tissues of the eyes and lachrymal gland in these cases has been demonstrated, so that although the species of worms involved have not yet been identified, there can no longer be any doubt that this condition is verminous in origin, and treatment has now become a simple matter.

Two other diseases which have recently been shown to be due to worm infection are hump-sore in cattle and prickly heat in horses. Both of these were under study during the year, and it has been found that these conditions are associated with worms of certain ascertained genera. But in neither case has it yet been possible to determine the exact species responsible.

The appointment of a Veterinary Research Officer to take charge of the Protozoology Section has been agreed to, and when he joins, the Institute will be in a position to undertake investigation of any problem in Veterinary Zoology that may arise.

The Imperial Council of Agricultural Research have agreed to provide funds for the investigation of tuberculosis and Johne's disease among animals in India and also for the investigation of contagious abortion and the Warble fly pest. The details of these schemes are now being examined, and it is hoped to commence work shortly.

There has been considerable demand for the major products of the Institute during the year, which shows that, as rinderpest is being brought under control, the field staffs are able to pay more attention to other livestock maladies, and that there is still very important work for the Biological Products Section of the Institute to do.

The Imperial Veterinary Research Institute, it may be noted, conducts researches into the diseases of domestic animals in India, and endeavours to prepare biological products for the prevention and cure of such diseases. When successful, these products are sold to local Governments, the Army, and even outside India. Muktesar, therefore, is not only a research institute but also a large manufacturing concern.

But though the primary function of the Institute is research, and it is not run on a profit-making basis, it so happens that a good deal of the expenditure on research is recouped through revenue from the sale of the products manufactured by the Institute and its Sub-Station at Izatnagar.

During 1935-36, the Institute supplied products, in the shape of serum, vaccines and diagnostic agents, to deal with such varied conditions as rinderpest, anthrax, haemorrhagic septicaemia (malignant sore throat), blackquarter, tuberculosis, Johne's disease, and contagious abortion in cattle, strangles, contagious abortion and glanders in horses, and fowl cholera and fowl pox in poultry. The total quantity of these products manufactured during the year was 31,39,469 doses, and a sun of Rs. 5,11,333|- was realized from their sale.

The total income of the Institute for the year, including all sales both at Muktesar and Izatnagar, amounted to Rs. 5,41,411|-, and the expenditure to Rs. 6,89,412|- so that the nett cost of the Institute to the Government of India was less than Rs. 1,50,000|-.

Survey of India

How few people know that though India is being mapped yearly at the rate of 40,000 square miles—an area roughly that of England—, yet she would require some 15 years more to have a complete modern map?

The work is being carried on, from year to year, not without occasional adventure, by the Survey of India, with its eleven Parties, through snows and sands, on mountains and in deserts, in forests and in plains.

But the hopes expressed in 1905—that modern maps on the 1″ scale would be available for the entire Indian Empire within 25 years—are still far from realization in 1936, just over half the total area of India having been completed by now on that scale. Although new surveys are carried out every year, covering nearly 40,000 square miles, the maps of a large part of this sub-continent are still over 50 years old, printed mostly in black only and with hill features shown by roughly sketched form lines or hachures; all such changes in town sites, canals and communications as have been embodied in them have not been surveyed on the ground but have been entered from data gathered from outside sources.

In 1918, when it was realized that for various reasons it would be impossible to complete the 1″ surveys in the time allotted, a scheme for the reduction of the scale of survey in the less populous areas was sanctioned by the Secretary of State. But in spite of the reduction in sale, only two-thirds of the country is as yet covered by modern maps. The tendency to revert to the 1″ scale in special circumstances, such as in areas of more than ordinary military, geological or engineering importance, the necessity which frequently arises to re-survey on the 1″ scale areas which have already been surveyed on smaller scales as they grow in importance, the necessity for the comparatively frequent revision of existing surveys in the more populous areas, and last but by no means the least important, the recent urgent necessity for economy—all these factors have operated to delay still further the completion of the programmes even as amended in 1918.

Owing to financial stringency, the establishment of the Department was severely cut down and its annual expenditure halved in 1931. Since that date, though original surveys are being carried out at the rate of about 40,000 square miles per annum, India would require some 15 years more to complete its survey programme.

During the year 1936, for which the report has just been published, survey was completed at 57,036 square miles, of which 3,987 square miles were areas previously surveyed in the more thickly populated districts and now brought up to date. Original survey was completed in 58,049 square miles on various scales, thus completing for India a total of 1,804,458 square miles of modern survey up to the present, leaving 580,187 square miles yet to be surveyed.

The methods used were mainly triangulation or traverse framework, with the details filled in by plane table, or in some cases surveys from air photographs.

Various largescale city and cantonment surveys were also carried out, the most notable amongst which was the combined air ground survey of Nagpur in the Central Provinces.

The first authoritative map of India, it may be noted, was published by D'Anville in 1752, when the exploration of the then unknown India was still largely in French hands. It had been compiled from reports of solitary travellers and rough charts of the coasts.

The Survey of India may be said to have been founded in 1767, ten years after the Battle of Plassey, when Lord Clive formally appointed Major James Rennell, the first Surveyor-General of Bengal, at the time the most important of the East India Company's possessions.

Rennell's maps were originally military reconnaissances, and later general surveys based on astronomically fixed points, and did not pretend to the accuracy of modern maps of India based on the rigid system of triangulation commenced at Madras in 1802 and since extended over and beyond India. Even now, however, the relative accuracy of these old maps makes them valuable in legal disputes, as for instance in proving that the holding of a Bengal landowner was river area at the time of the Permanent Settlement of 1793, and that he is therefore, debarred from the benefits of the Permanent Settlement.

From these beginnings, this Department (the Survey of India) has gradually become primarily responsible for all topographical surveys, exploration and the maintenance of geographical maps of the greater part of Southern Asia and also for geodetic work.

In the past the Department used to carry out large scale revenue surveys for most of India and was still doing this work for Central and Eastern India and Burma in 1905. Though the revenue survey is primarily a record of individual proprietary boundaries and has nothing to do with surface features, ground levies and exact geographical position essential to a topographical survey, it was on the whole found economical to carry out both these surveys together.

By 1905, however, the smallscale topographical surveys, compiled from the largescale revenue maps, had fallen seriously in arrears owing to the relatively smaller compass and incompleteness of the latter, on which "waste" non-revenue-paying areas are normally shown blank.

An authoritative Survey Committee appointed by the Government of India considered the position in 1905. It was apprehended that the separation of the topographical and the revenue surveys might result in a wasteful duplication of work and in the overlapping of two mutually discrepant systems of mapping. It was decided, therefore, that the basis of both the systems of survey should be identical, and be provided for by the Survey of India or under its supervision. Subject to this principle, the remaining revenue surveys were handed over to the Provinces and the Survey of India was put in a position to concentrate its energies on a complete new series of modern topographical maps in several colours on the 1" to the mile scale.

This new series had been rendered necessary by the natural demand for more detailed information to be shown on maps, especially as regards the portrayal of hilly features by contours, proper classification of the communications, and recently by air traffic requirements.

It was intended that this 1905 survey should be completed in 25 years, and then revised periodically every 30 years. Owing, however, to the War, and more recently retrenchment, only about two-thirds of the programme had been completed by 1936 in spite of the reduction of the scale for the less important areas.

The maps published during the year include topographical maps on scales between 1/8" and 1" to the mile, small geographical maps on scales of 16 and 32 miles to the inch, and special guide maps, Province maps, etc. The total number published during the year was about 650, and the total map sheets now in stock and available for issue to the public number 2½ millions.

The Mathematical Instruments Office, maintained by the Department at Calcutta, assists all Government Departments as well as non-official by maintaining up-to-date instruments and optical equipment and by manufacturing and repairing instruments which would otherwise have to be replaced from abroad.

An important part of the activities of the Department was its geodetic work. Essential as geodesy is in any large survey, it may be said to the credit of India that she was the first to have initiated systematic gravity investigations now being carried out intensively in all civilized countries. Indian geodesy has disclosed widespread anomalies of the gravitational direction in the earth's crust which have recently led to a reconsideration of the whole theory of isostasy.

Geodesy means the investigation of the size, shape and structure of the earth, whereby points fixed by triangulation can be accurately located on its curved surface. This system of fixed points holds together all topographical and revenue surveys, and the existence of such a system from the early days of the Department has enabled to evade the embarrassments caused in other countries where isolated topographical surveys have been started without a rigid framework with the inevitable result that they could not be fitted together.

There are, however, a number of other activities which can be suitably combined with geodetic work, and the following are some of those which are being carried out in India:—Precise levelling for the determination of heights, tidal predictions and the publication of Tide Tables for 41 ports between Suez and Singapore, magnetic survey, observations of the direction and force of gravity, astronomical observations to determine latitude, longitude and time, and seismographical and meteorological observations at Dehra Dun.

Though the primary duties of the Survey of India are geodetic, topographical, and geographical, the Department is also developing co-operation with local survey agencies with a view to mutual economy, and is now doing a considerable amount of miscellaneous outside work on payment, besides advising and assisting the Provincial Governments with local and settlement surveys as required.

A special Party, it may be mentioned, was formed in October 1935, to assist the Sino-Burmese Boundary Commission.

The work of the Department during 1936 has not been without adventure. A Party penetrated the "Inner Sanctuary" of Nanda Devi, of which they made a photographic survey under very arduous conditions. A surveyor and his party were almost overwhelmed by a severe snow-storm in the upper reaches of the Gangotri Glacier in Tehri-Garhwal, and narrowly escaped with their lives. Surveyors accompanied the Visser Expedition to the Karakoram in 1935, which returned to India shortly after the opening of the present survey year, with satisfactory results, and a surveyor is still with Sir Aurel Stein on his archaeological expedition to Iran. And it goes without saying that in portions of the area under regular survey, elephants, tigers, and panthers were numerous and gave the alarmed surveyors some uneasy moments.

The net actual cost of the Department for the year, after deducting recoveries amounting to Rs. 10 lakhs, was Rs. 24 lakhs.

Archaeological Survey of India

Had India a pre-historic civilization—long before other countries of the world which have a history had any?

A partial answer to this question will be found in the consolidated annual report of the Archaeological Survey of India just issued by the Director-General of Archaeology. The record of the steady and continuous discoveries made during the last decade almost makes one think that the time is not far distant when it would be possible to write the ancient history of India anew, with fuller and more accepted details.

A linear measure with regular markings showing once again and confirming the conclusion already arrived at as a result of a previous discovery of graduated weights in the decimal and binary scales, that the decimal system was known and used in India in about 2700 B.C. was one among the interesting discoveries made at the excavations at Mohenjodaro in Sind which were continued up to the end of 1931. Amongst the other important finds are a clay seal depicting a complicated legendary scene of tree worship and a drawing of great interest portraying a river boat. Evidence has also been found about the recurrence of floods which brought about the decay of the town.

Excavations at Harappa, the other city of the ancients in the Punjab, conducted by Mr. Madho Sarup Vats, have resulted in the discovery, amongst other things, of a number of skeletal remains and pottery jars with skulls and human bones. These are about the only definite burials known of the ancient Indians in the Indus Valley. Another discovery as a result of recent excavations is a portion of the city which can justly be described as workmen's quarters in contradistinction to the more substantially built and commodious houses of the rich and middle classes.

A brief account is also given of Mr. N. G. Majumdar's valuable explorations in Sind. These explorations reveal the existence of a number of prehistoric settlements, some in the hilly region and others on the banks of a lake, and add to our knowledge of the conditions of life in those far-off times.

Other important excavations during the period covered by this report were those at Paharpur in Bengal, Nalanda in Bihar, and last but not the least at Taxila in the Punjab.

The excavation of the lofty temple and magnificent monastery of Paharpur which started in 1923 has now been completed, together with the excavation of a similar site almost adjoining it, known as Satya Pir Bhita, which is now identified as the temple of Tara, the Buddhist Saviouress. The Monastery of Paharpur, measuring 922 ft. by 919 ft. contained nearly 200 cubicles for monks, arranged around a vast courtyard with an imposing four-terraced temple in the middle and various other structures at other points ranging in date from the 5th to the 11th century A.D. The structural complex at Paharpur is one of the most gigantic establishments ever found in this country. The credit for this magnificent piece of archaeological work goes largely to Rao Bahadur K. N. Dikshit.

Nalanda, one of the most prominent centres of Buddhist learning and devotion over a thousand years ago, is now found as a result of systematic excavations to have consisted of a series of sacred shrines and monasteries erected in rows. Several further shrines and monasteries have been brought to light, although the operations are as yet far from complete. The most important discoveries at this site are some extremely fine stone images of Buddhist deities and a large hoard of bronze images belonging to the 6th—10th Centuries A.D., of many of which photographic plates have been given in the report.

The most intensive campaign of excavation conducted by the Archaeological Survey at one place is at the ancient site of Taxila, which has from the earliest times dominated the approach to the Indian plains from the North West. The present report contains the last contribution on the work at Taxila from the pen of that distinguished excavator, Sir John Marshall, who personally conducted this work for over 20 years and has left behind him in India a splendid example of how such work should be conducted. In an introductory review, Sir John summarizes his latest conclusions on the various influences that are in evidence at Taxila and gives an illuminating analysis of successive cultural strata which he has so skilfully unearthed. To the dozen or more sites comprised within Taxila, which have already been explored, Sir John has added two more, namely Bhamala and Kalawan Monasteries, which were cleared during the period covered by this report.

One of the most interesting portions of the report deals with the discovery of Buddhistic and Brahmanistic wall paintings in Burma by Maung Mya. These are fully illustrated in the plates and the coloured frontispiece reproduces an exceedingly interesting and fine fresco of the 10th—11th century, a period of which no paintings had hitherto been known.

Details are also given of voluminous epigraphical works and of numerous discoveries made during the years covered by the report. The museums during this period have been steadily enriched with numerous objects of the greatest interest and value to archaeologists and lovers of art. Among those so enriched the Archaeological Section of the Indian Museum at Calcutta of course ranks the foremost. But all the minor museums under the care of the Department, at Taxila, in the Delhi and Lahore Forts, at Sarnath, at Nalanda, at Mohenjodaro, and at the Central Asian Antiquities Museum, New Delhi, also have had fresh acquisitions.

A long enumeration of finds of various importance, among which the most outstanding is the large find of medieval bronze images at Kurkihar, now deposited in the Patna Museum, is recorded in the section on Treasure-trove.

Excavations and new discoveries were, however, not the only activities of the Department during these years. Active steps were taken for repairing and restoring what time had made dilapidated and decayed, and the Archaeological Chemist, Khan Bahadur M. Sanaullah, was exclusively employed on this work. The number of monuments which have been repaired by the Department during the years under review, runs into hundreds, of which the two outstanding instances are the extensive conservation work carried out at the ancient Buddhist Monastic School of Nalanda in Bihar and at the other famous Buddhist site, Rajgir, where during the repair works and the clearing of the neighbouring ground, another cave of considerable historical importance was discovered.

The report now issued chronicles the activities of four years ending March, 1934. A novel feature and one of great value to students and interested readers is the addition of an index at the end as well as a short but useful glossary of technical terms.

It may be mentioned that the results achieved were obtained in the face of heavy odds. "Although there are a number of discoveries of no mean importance embodied in this volume", the Director-General of Archaeology observes, "the year 1931 marks the beginning of a severe financial stress and a general decline in the activities of the Department. All the branches of the Archaeological Survey have suffered from this serious handicap of lack of money; excavations had to be reduced to the minimum, and conservation confined to the most urgent repairs only".

Air Survey of Nagpur

A 16-inch to the mile map of Nagpur City and its environments has just been completed from air-photographs taken by Indian Air Survey and Transport Ltd. combined with ground-survey, drawing and map printing by the Survey of India. The total area mapped covers approximately 32 square miles, of which 14 are mainly congested city area and 18 are suburbs and surrounding country; the map of the city area was produced by rigid survey methods and will be published in colours, while that of the rest is taken more directly from the photographs, with less ground check, and will be in black only.

This method of air-cum-ground survey is being adopted widely in India as it affords far the cheapest and quickest method of producing accurate maps of congested areas on medium scales. A further advantage is that a photo-mosaic can be prepared which supplements the information appearing on the map, and on which every tree and bush is easily discernible. The stereoscopic examination of pairs of photos yields a perfect picture of the ground in miniature on which everything stands up in relief. When preparing the map, to correct any distortion, to clear up doubtful points and to complete such areas as are hidden by trees, etc., it is necessary to ink up the photographs on the ground, after taking the necessary measurements, etc. This inking up was done, in the case of Nagpur by a new method of working on blue-toned prints, the blue disappearing when the field sheets are subsequently photographed for completion of the map.

Apropos of air-survey, it may be mentioned that a folding mirror stereoscope for the stereoscopic examination of air-photographs has recently been made by the Mathematical Instrument Office of the Survey of India and has been found very satisfactory.

Science in Industry

Indian Lac; its Possibilities

A recent estimate made of the production and consumption of indigenous lac reveals how India is yet far from making the fullest use of her lac wealth. The total lac production in British India though yet much below her producing capacity was in 1935 11,27,000 maunds, and the value of lac exports amounted that year to Rs. 1,58,46,855. The home consumption, however, was only 24,000 maunds, or barely 2 per cent of the total production, and approximately equivalent to 8 per cent of the total exports. These figures tell their own tale, and show that the industrial possibilities of lac yet remain unexplored in India, while good use is being made of it by those who are importing it.

The only well known and widely adopted use of lac in India is for polishing furniture. Most of the carpenters in Northern India, if not all, buy small quantities of shellac at a time, dissolve it in methylated spirit and use up the polish for their immediate requirements. But this use of lac can obviously absorb only a very limited quantity of the produce. Another use for it is in hot lacquering of wooden toys, penholders, etc., with coloured lac sticks. But in this use, too, the consumption, though on the increase, is yet very small. A third way in which lac is utilized is in the manufacture of bangles from refuse lac. Refuse lac is also used in filling hollow gold and silver articles. But in both these uses consumption is on the decrease. On the whole it is not perhaps incorrect to say that all the above uses put together do not take up even one per cent of the total lac produce in India.

So far as shellac moulding is concerned, it appears to be confined in India only to the manufacture of gramophone records. Originally in plastic moulding, use was made of rubber, bitumen, nitro-cellulose, casein and similar other materials. Shellac came in when it was found that it could be used in the moulding of telephone mouth-pieces, electric insulators, buttons, etc. But shellac was only one of a number of other suitable materials for the moulding trade, till the rise of the gramophone record industry gave shellac the unique place in the industry which it now occupies, no synthetic resin having yet been able to replace it in this field. Among high-class gramophone records, those with a shellac base are still undoubtedly the best.

The steady improvement in the condition of the lac industry from 1900 onwards is due in a large measure to the growth of the gramophone industry. At present, 40 to 50 per cent of the total output of lac is consumed in the manufacture of gramophone records. Though the radio threatens to be a formidable rival to the gramophone, it is possible that this increasing competition will only bring about for a long time to come a diversion of markets rather than a shrinkage. In the East, for example, there is yet a large potential market for gramophones. It is not improbable that it is largely to explore this market that Japan during the last two years has considerably increased her takings of shellac. A few new ventures are also being started in Bombay and Calcutta, but in its present state, the local industry consumes no appreciable quantity of the total.

The gramophone industry, besides being the largest moulders, has taken up elsewhere other types of moulding too. In Tonbridge, Kent, for instance, handles (electrical), hand wheels, wireless control knobs, panels, etc., are being manufactured from lac. In addition, it appears that shellac is being used, either alone or in combination with synthetic resins, for the manufacture of moulded articles known as Duranoid, Lacanite, and Insulate produced in the United States, and Solidite produced in England.

In the electric insulation trade, shellac mouldings were of very common occurrence nearly 15 years ago, but the advent of synthetic resins has affected shellac in uses where higher thermal resistivity is required. But because of its relative cheapness, its superior performance in a special field (where sparks are likely to create tracks), and its improved thermal properties on prolonged baking, shellac still holds its ground successfully, in many spheres. In the electrical industry, therefore, there is yet considerable use for lac products, chiefly as insulating varnishes and as a bonding material for laminated insulating articles, such as paper boards, paper tubes, etc., and for bonding mica flakes to form micanite sheet. It is also used as a bonding cement for basing electric light bulbs and wireless valves.

In the moulding of buttons, shellac has practically given place to casein, urea resins, and cast phenolics, and so far as the moulding of general utility wares is concerned, the phenolic and urea resins have practically created for themselves the field which they are now supplying and shellac had never a place in it.

But still there is a wide range of miscellaneous industries which use shellac. Of these, mention may be made of the hatting trade in which lac is used as a stiffening agent. Nearly 10 per cent of the annual lac output is consumed in this industry, and in this line synthetic resins have not made much advance yet. Other industries which use shellac are sealing wax manufacture, leather finishing, rubber finishing, paper finishing, photographic negative varnish, tinfoil finishing, manufacture of lithographic ink, cements and gums, munitions and fire works, emery grinding, wheel industry, and confectionery.

In general, it may be said that in spite of the introduction of synthetic resins, the export of shellac has not sensibly diminished, and that in the plastic field, shellac fulfils practically all the requirements of the gramophone trade and a fraction of the electric insulation trade, but with improvements in heat resistance and mechanical strength, a very wide field of application which the synthetic resins have opened up can still be exploited by shellac, either alone or in combination with other resinous materials. The Indian Lac Research Institute at Namkum and its fellow research organizations in London and New York are actively engaged in investigating these openings, together with the possibilities of improvements in cultivation, pest control, etc., which will lead to the production of a better grade of raw material.

In the moulding of common articles like containers, soap cases, bottle caps, pen and inkstands, pin cushion bases, knobs, door handles, etc., the results already attained by the Indian Lac Research Institute are considerable, and with proper assemblage of factory equipments, the country may hope to see the inauguration of this important industry in the near future.

The semi-technical isolation of hard lac by the London Workers under the Lac Cess Committee has opened up the prospect of a new field for shellac in practically every industry which requires better mechanical, thermal and electrical properties. The recovery of waste shellac, an important factor in the indigenous process of shellac manufacture, has also been tackled by the Indian Lac Research Institute which will have an important effect on the general quality of shellac and shellac products. An encouraging factor is that the present price of shellac is half of the price of bakelite or moulding powder.

During the last session of the Council of State, it may be noted, in reply to a suggestion that the duty on bakelite powder should be reduced, Government explained that as moulded goods were also being manufactured in India from Indian lac, reduction of duty on moulding powder (bakelite or other types) would effect prejudicially the prospects of such manufacture from indigenous natural lac.

With the wide range of utility which shellac possesses, should not Indian enterprise be forthcoming to exploit a produce which is practically a monopoly of India and which India can produce in yet larger and larger quantities? There are possibilities of expansion both in the external and internal markets and India must needs explore both.

Vegetable Oils and Oilseeds

The Imperial Economic Committee, in a statistical review of world production and trade entitled *"Vegetable Oils and Oilseeds"*, points out that the consumption of fatty oils of vegetable origin has developed enormously with the increased demand for fats, although animal products, that is butter, lard and tallow, remain the principal individual fats of commerce. The seeds and nuts of many different plants and trees can be made to yield oil, the review deals with those of chief commercial importance, (and in view of the strength of its rivalry adds a statement on whale oil.)

The British Empire, particularly in India and the Colonies, is an important producer of vegetable oils and oilseeds, and many parts of the Empire carry on a considerable export trade. On balance, the

Empire has a substantial net export for many of the oilseeds and nuts, notably ground nuts, palm kernels and copra. There is, however, a large net import into the Empire of cottonseed, linseed, and soya beans.

Prices for vegetable oils and oilseeds fell severely during the depression. The lowest sterling prices were reached in 1934. Despite the improvement which took place in 1935 the average prices in that year for most kinds of oils and oilseeds ranged between 50 and 70 per cent of the 1927-29 average. There was generally a further improvement in 1936.

A feature of special interest is an Appendix analysing the utilization of fats and oils in the United Kingdom, by the soap, margarine and compound lard industries between 1927 and 1935. This has been rendered possible by the co-operation of the manufacturing firms. The analysis shows that the soap industry uses about 200,000 tons of oils and fats annually, but that consumption in the margarine industry declined from a peak of 176,000 tons in 1929 to 135,000 tons in 1934, recovering somewhat to 147,000 tons in 1935. There has been a considerable increase in the manufacture of compound lard, consumption of oils and fats for this purpose has risen steadily from 29,000 tons in 1927 to 73,000 tons in 1935.

In respect of all three products, the outstanding development has been the increasing utilization of whale oil. In the soap industry, the proportion of whale oil used has increased from 5 per cent in 1927 to 18 per cent in 1935. This has been at the expense of animal oils and fats; the proportion of vegetable oils (chiefly palm, palm kernel and cocoanut) was actually higher at 63 per cent in 1935 than it had been in 1927. In the margarine industry, whale oil increased over the same period from 16 to 37 per cent, chiefly at the expense of vegetable oils (mainly cocoanut, groundnut, palm kernel and cottonseed.) In the manufacture of compound lard there was little change until 1935, when the proportion of vegetable oils fell, and that of marine oils advanced. Despite this the actual quantity of vegetable oils used in making compound lard was higher than ever.

Cottonseed is an important source of income to the cotton farmer. Almost the entire output in the United States, which is by far the largest producer, is consumed at home and exports from India, the second largest producer, have been negligible in recent years. Egypt, the Anglo-Egyptian Sudan and Uganda are the principal exporters of cottonseed, while there are only two large importers, the United Kingdom and Japan.

Argentina, the largest producer of linseed, accounts for over four-fifths of the world exports. India and Uruguay are next in importance. Imports into the United Kingdom come almost entirely from Argentina and India and since 1933 the latter has been the chief supplier except in 1935.

India and China are the principal producers of groundnuts, but both retain a large part of their production. Senegal, Nigeria and the Gambia, on the other hand, export the greater part of their output. France, the first European country to import groundnuts, still maintains its place as the leading importer.

The largest exporters of copra are the Netherlands, East Indies, and the Philippines, the latter also shipping large quantities of cocoanut oil. Exports from Empire countries amount to roughly one-third of the world total. British Malaya and Ceylon are the chief Empire exporters, but the trade is of greatest importance to Fiji, accounting for about 13 per cent of the value of all domestic exports between 1931 and 1935. Imports into the United Kingdom, which have tended to increase, are now shipped entirely from the Empire.

Indian Lac Industry

H. K. Sen

Director, Indian Lac Research Institute, Ranchi.

[During the last session of the Indian Science Congress held in Hyderabad in January 1937, Prof. Dr H. K. Sen, Director of the Indian Lac Research Institute, Namkum, drew the attention of the scientific gathering to the lac industry by means of an interesting two-reel cinema film at the Town Hall and opened a discussion on 'The Problems of Shellac Chemistry' in the Chemical Section of the Congress. The film showed how lac is cultivated and manufactured into shellac and what the principal activities of the Research Institute at Namkum are, in the region of entomological and chemical investigations. The following article is based on the lecture referred to.

Editor—SCIENCE AND CULTURE.

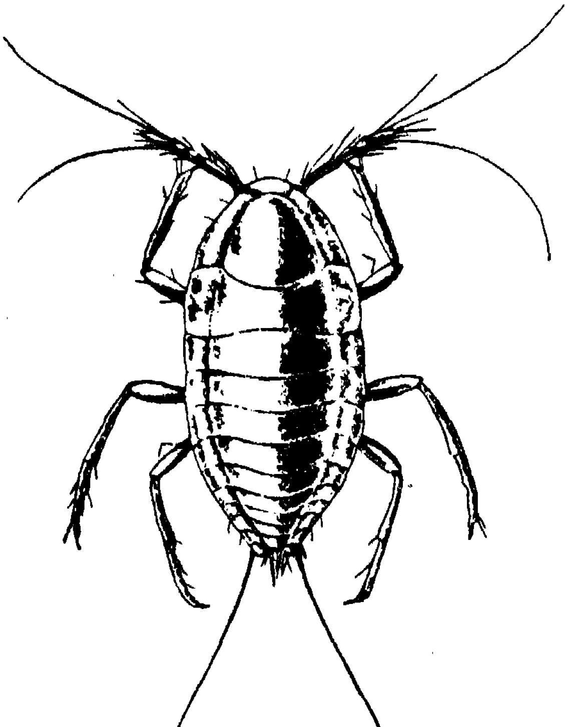
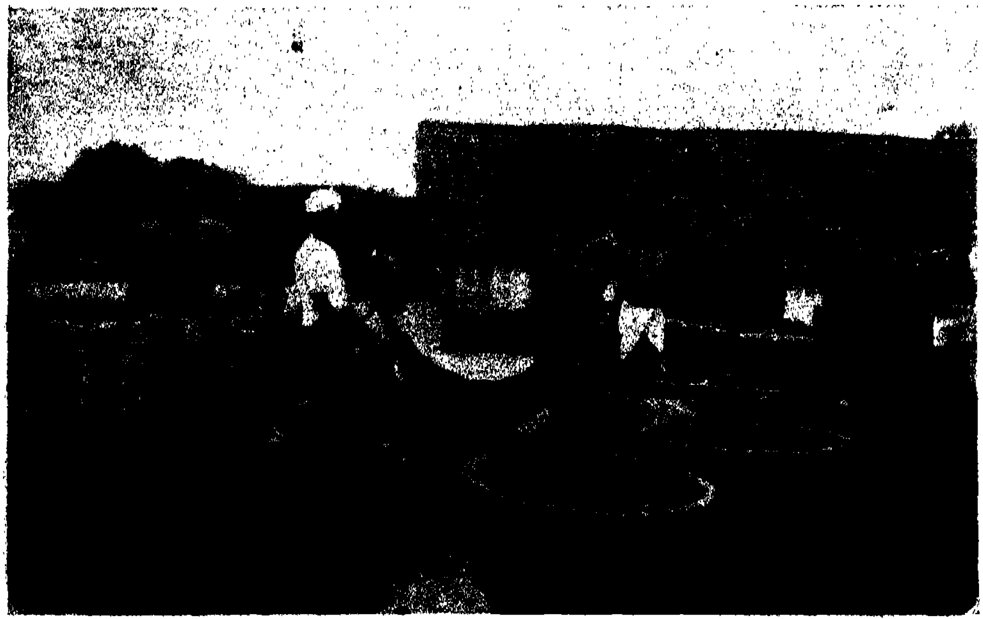


Fig. 1. *Laccifer* (*Tachardia*) *lacca*, Kerr, o larva immediately after emergence.

Lac holds a unique position among natural resins in so far as it is the only one secreted by an insect. Hardly measuring half a millimetre at birth but swarming in millions, the lac insect produces 60,000 to 70,000 tons of raw lac year after year. Approximately, 8,400,000,000,000 female insects are responsible for this output, the male taking practically no share in it. Lac and lac-dye have been known and used in India from very ancient times, but it is only since the beginning of this century that its economic importance was realized. With the advent of synthetic dyes, lac dye for which lac was initially prized was forgotten, but the resin occupied the important position which it now does. In numerous industries, lac plays its part, in most instances, however, only in small proportions, the aggregate of which is very considerable. An idea of its use may be had from the percentage consumption of the total lac in the various big industries:—Gramophone records (35-40%), electrical insulation (15-20%), paint and varnish industry (15%), hat stiffening (10%), sealing wax (5%), lacquering, grinding wheels, etc. (the rest). The consumption of shellac was confined till lately to the highly industrialized countries of Europe and America, but recently Japan and Russia have been importing large quantities of the resin. India and Burma account for 95% of the world's production of shellac, and yet less than 3% is utilized in the country of its origin. The production has kept pace with the demand, and the capacity to meet steady increased requirements seems well-nigh unlimited. The exports of shellac have increased from 2,000 tons in 1868 to 10,000 in 1900 and 35,000 in 1936. Roughly, one part of shellac is produced from 2 parts of raw lac, called scraped lac or sticklac.

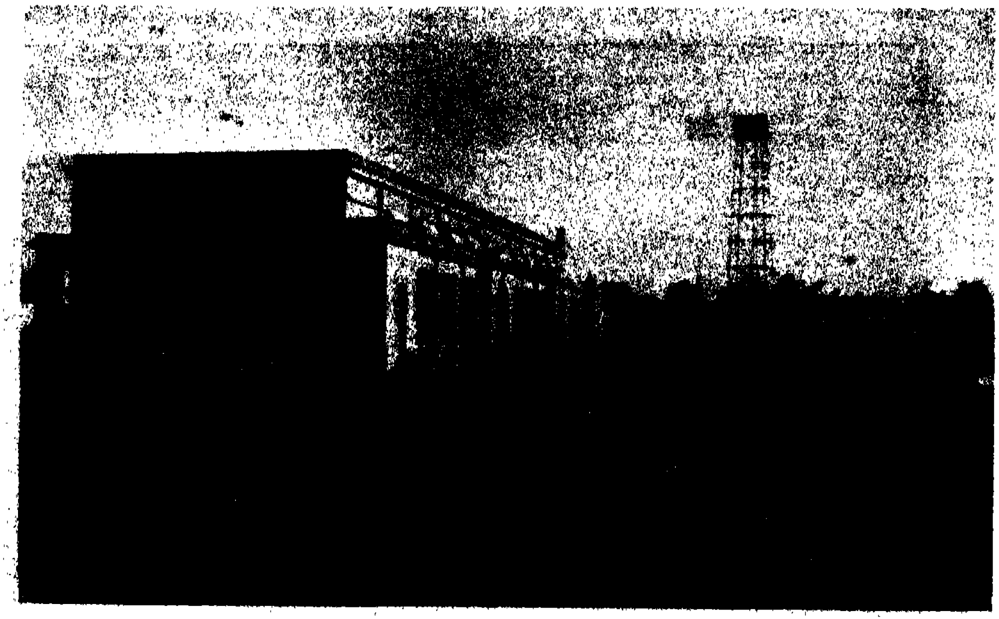
The lac insect (Laccifer lacca) is very exclusive, flourishing at its best in Bihar and the Central Provinces, although certain parts of the Punjab, Sind, Bengal, Assam, Burma, Hyderabad, and Mysore provide hospitable surroundings for it. The favourite trees (called 'hosts') for the insect are Kusum (*Schleichera trijuga*), Palas (*Butea frondosa*), Ber (*Zizyphus*

Manufacture oi Shellac—Refining.



Washing Lac.

Scraping Lac from twigs of ***Zizyphus Jujuba*** (***Ber.***)



The Indian Lac Research Institute, Namkum, Ranchi.

jujuba), and Khair (*Acacia Catechu*). The insects settle on the fresh shoots of these trees, and deriving their sustenance from the sap of these trees, secrete lac as a resinous coating over their bodies. After a few months, when they have run their life-cycle and produced the maximum amount of resin, the next generation of larvae are ready to come out and settle on other trees.

The lac-encrusted shoots are now cut off the trees (at this stage they are called 'broods') and temporarily tied on the branches of other fresh ones to help the young ones find their settling places. When the 'swarming' and settling are over, the old lac sticks are removed from the branches and utilized for shellac manufacture. For this purpose, lac is first scraped off the twigs, crushed lightly, washed in water to remove the dead insect bodies, dye matter, etc. and dried in the open. It is obtained as an amber-coloured granular material, called *Chowri* or *seedlac*. The chowri is next packed into long sausage-shaped cloth bags, (about 40 feet long), held in front of a charcoal fire and twisted. The lac melts and flows out through the pores of the cloth which, acting as a strainer, retains the impurities (called "Kiri") inside. The clean matter, lac, is either dropped on a cold surface to solidify in round button-shaped pieces (button-lac) or stretched into thin sheets called shellac.

On the recommendation of a Committee of Enquiry appointed by the Government of India, the Lac Research Institute was started in 1925 for studying the scientific basis of lac cultivation in all its aspects, *viz.*, biochemical, entomological, and silvicultural. The life-history, morphology, etc., of the lac insect and those of two important predators, *Eublemma amabilis* and *Holcocera pulverea*, have been exhaustively studied at the Namkum Research Institute. The damage done by these predators is very serious, amounting to 80-85% of the crop, and simple methods have been worked out to minimize, if not eradicate, them completely. Two other insects, *Microbracon greenii* and *Microbracon hebetor*, have been found to destroy these, and the application of this discovery in a practical manner by breeding them in large numbers and liberating them in lac-growing areas is under examination. The efficiency of lac secretion will depend on the provision of suitable healthy fresh shoots on the host trees by keeping them free from pests and pruning them at the proper season preceding lac infection. The plantation attached to the Institute, where these experiments are carried out on a field scale, is stocked with all the principal host-trees and covers an area of 80-90 acres.

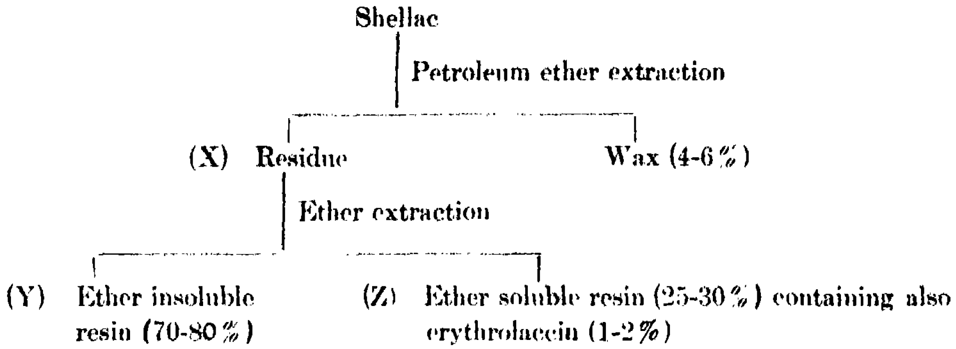
In recent years, the Institute has paid greater attention to improvements in the methods of manufacturing lac and their application in the industries. More important amongst these are the reconditioning of old and deteriorated lac, improvement of shellac varnishes as regards water and weather resistance, bleaching of lac, modifying properties of shellac by combination with sulphur, urea, polycarboxy acids, etc., and the utilization of shellac and its by-products in making plastic moulded articles. The Institute is well equipped with all the necessary appliances for preparing the above on a laboratory scale and testing them according to standard methods. An air-conditioned room maintained at 25°C and 60% relative humidity serves for testing paint and varnish films, whilst there exist in the Institute hydraulic presses and standard testing equipments for plastic moulded articles.

The Lac Cess Committee has established research centres in London and New York for solving the immediate problems of the consuming industries and finding new uses for lac. In London, isolation and utilization of the harder resinous part of lac (70-80%) has given promise of a wider field for the utilization of lac, and sulphited and fatty oil-acids-modified lac are expected to lead the way to further uses. In America, improvements in shellac-moulded articles have been investigated and problems arising out of the shellac varnish industry as regards solvent media, proper packaging to prevent deterioration during storage and wearing properties on outdoor exposure have been largely solved. The future for shellac as regards consumption in foreign countries as well as the possibilities of increased use in India are definitely bright, provided speculation and adulteration do not jeopardize its price levels or quality. Synthetic resins, whilst possessing some decidedly better qualities, yield to shellac in many others, the most important of which is its low price.

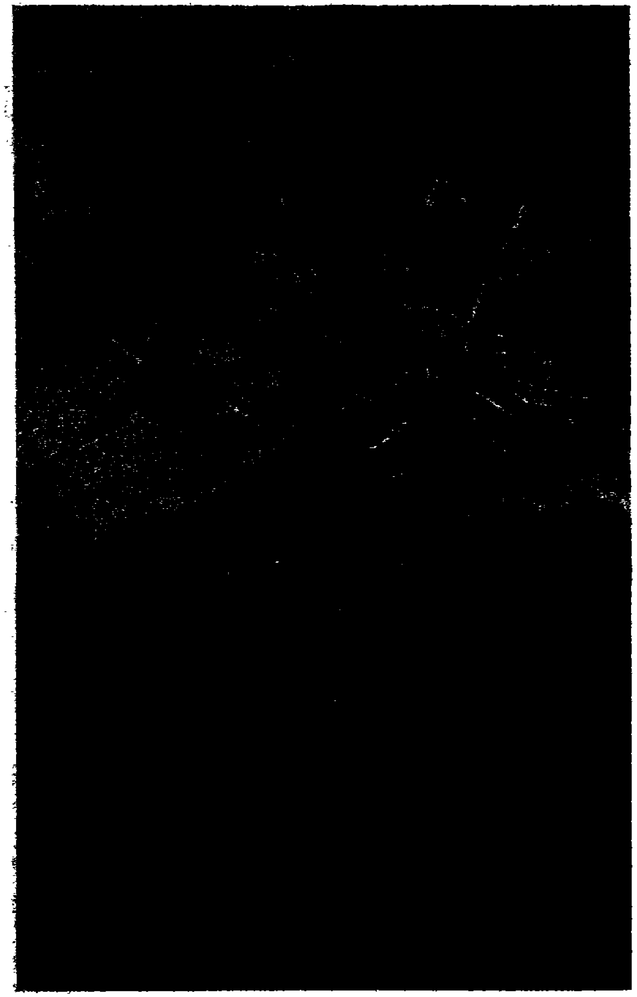
Sticklac, *i.e.*, lac as obtained from the host trees, contains dyes, waxes, lac-resin itself, albuminous matters, and extraneous impurities. (*a*) The dye for which initially lac was so much prized may be divided into two parts: the water-soluble portion which is mainly laccaic acid, the constitution of which is as yet doubtful, being a mixture of acids probably of anthraquinone origin; the water-insoluble but alkali-soluble portion of the dye, erythrolaccin, has been more definitely identified to be a tetrahydroxy methyl anthraquinone. The total lac dye is about 5-6% of the sticklac, of which the water-soluble portion gave the dye of commerce. The colour of seedlac or shellac is due to erythrolaccin. (*b*) The waxes constitute also about 6% of sticklac, and are a mixture of myricyl and ceryl alcohols, free, or combined with melissyl and cerotin oils and palmitic acid. (*c*) The lac resin itself forming about 75-80% of sticklac has been considered as a mixture of hydroxy fatty acids either as lactides or lactones or as both. The free acidity of lac is regarded as being due to such carboxyl or portion of carboxyl that has not had the chance of lactiding or lactonizing due to positional relationship between the reacting groups (OH and COOH). The possibility of an equilibrium between lactide, lactone and free acid group cannot be also altogether ignored, seeing how sensitive lac is to various reagents. The polymerization of the hydroxy-acid molecules amongst themselves by mutual condensation is thus clear, and this tendency encourages one to look for more polymerized products by chemical or physical treatments in the laboratory. (*d*) The albuminous matters associated with sticklac are the results of the insect secretion, and (*e*) the extraneous matters find their way during collecting, scraping, and storing sticklac. These latter are mostly sand, pieces of wood, etc.

Although there is adhering moisture in sticklac, seedlac, and shellac, on attempting to dry a sample, elimination of water through condensation does take place. This is an important problem in lac research, as the viscosity and a few other properties depend upon the moisture content.

The natural lac resin does undergo slight modification in its being converted into shellac. The purest shellac of commerce can be separated into three fractions with distinct properties by successive extractions with petroleum ether and ethyl ether:


Shellac
Petroleum ether extraction
(X) Residue
Wax (4-6%)
Ether extraction
(Y) Ether insoluble resin (70-80%)
(Z) Ether soluble resin (25-30%) containing also erythrolaccin (1-2%)

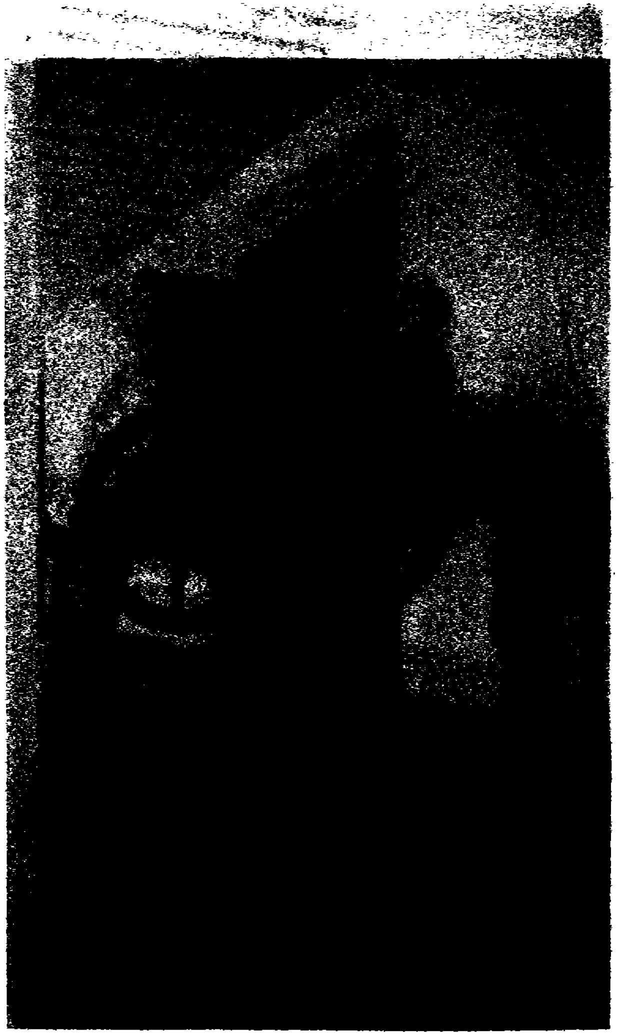
The chemical and physical investigations of shellac have centred round the residue (X), as (Y) has been found more suitable for certain insulating varnish purposes. In all varnishes two characteristics must be present, the coating or film property as also the plastic property. It is, therefore, necessary to add 'plasticizers' to resin materials when they are absent. Fortunately, shellac has an almost ideal plasticizer in it, the ether-soluble portion, which, though unwelcome for certain specific purposes, *e.g.*, quick hardening lends to shellac the superiority it enjoys. The free acid value of shellac is between 60 and 70 and the 'ester value' 220 − 60 = 160. These values have reference to the milligrams of KOH per gram of shellac. The titration of alcoholic shellac solutions being inconvenient except with the help of outside indicator (bromothymol blue is generally used) on account of the darkness of the solution, a method is being developed at Namkum dependent on the change of flourescence of neutralized shellac solutions in the presence of ultraviolet light.



Acacia Catechu (Khair) infected with Lac.

Manufacture of Shellac—Stretching.

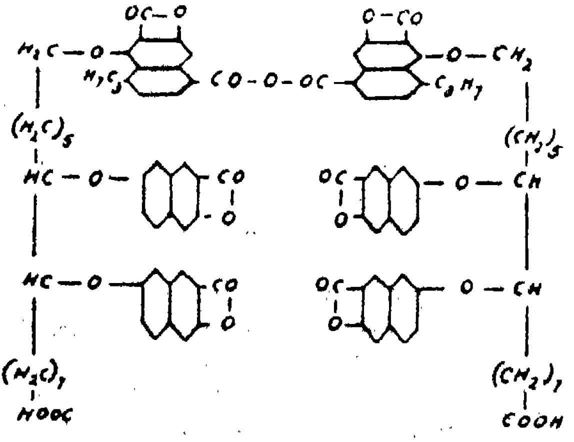
Acacia Catechu (Khair) pruned in preparation for infection with Lac.



Grinding Stick Lac.

The technique leaves as yet somewhat to be desired, but the suitability of this method seems certain.

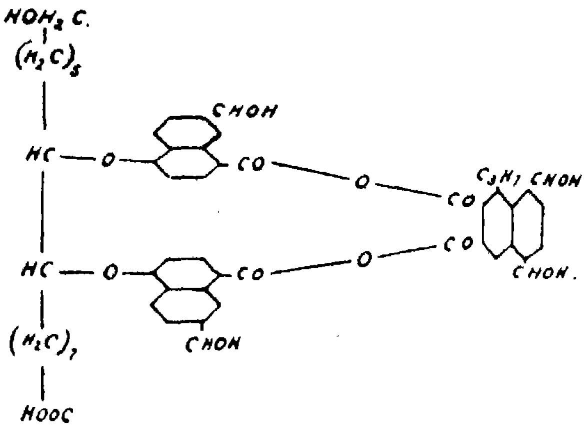
The action of alkali, strong and weak, as also bicarbonate of sodium, is a next item of research, although much has already been done on this head by previous workers. A clear understanding of the action of alkali is expected to throw much light on the constitutional questions of the shellac complex. So far, all attempts at isolating the various constituents of shellac (ether soluble or insoluble) have been preceded by its hydrolysis which has naturally caused deep-set changes in the shellac complex. Inferences, therefore, however useful, cannot be regarded as flawless. To take an instance, the isolation of the only two known acids, aleuritic and shellolic, has been effected after a tolerably severe hydrolysis by alkali of the shellac complex, and it may be reasonable to argue that these two acids do not probably exist in the way in which investigators have represented to build up the shellac molecule. Nagel and Baumann (*Wiss. Veröff. Siemens-Konzern*, Vol. XI, page 104, 1932) have given to the shellac complex the following formula, (I), whilst Bhattacharya and Verman have made an alternative suggestion (II)*:



Formula I

From our experience, an ether linkage is more unlikely, though ether from a secondary alcohol may be assumed to be easily susceptible of hydrolysis by alkali. This point requires to be settled by the actual study of hydrolysis of ethers from aleuritic and shellolic acids.

As aleuritic acid is the only substance the constitution of which may be taken as definite, and as it occurs in 20% yield of shellac, the largest of any known definite chemical substance in the resin, its technical production for self-polymerization, or polymerization with synthetic chemicals, has been given attention to. As a result, a commercially feasible method of preparing the acid, based on its precipitation by the treatment of saponified lac solution with hydrochloric acid and aluminium salts has been developed at the Indian Lac Research Institute. This has made two further investigations so far possible, the self-condensation of aleuritic acid under heat and the formation of clear, water-resistant synthetics with phthalic acid, with requisite plasticity to allow of the condensation product being used for coating fibres for water proofing, adhesives, etc. Aleuritic acid may also be expected to take part in fine and heavy chemical industries.



Formula II

The distillation of the calcium salts of both aleuritic acid and shellac (or 'Kiri', a by-product of little value in the shellac manufacture) has opened up a new line of investigation, yielding ketones and several terpenes, the heavier fractions of the latter being suitable for the commercial production of cart grease, and paint vehicles. The high iodine value of the oils indicates the temperament of the two contiguous hydroxy groups in aleuritic acid, whilst their property of dissolving raw rubber may be useful in rubber-shellac combinations.

The oxidation of aleuritic acid has given rise to the following products:—

1. The half aldehyde, $CHO(CH_2)_7COOH$.
2. Azelaic acid, $COOH(CH_2)_7COOH$.

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* Unpublished information

3. The alcohol aldehyde $CH_2OH\ (CH_2)_5CHO$.
4. Pimelic acid $COOH\ (CH_2)_5COOH$.

Besides, there is reason to believe that the dialdehyde of pimelic acid, $CHO\ (CH_2)_5CHO$, is also in our hands. These oxidation products point to the accepted constitution of aleuritic acid as trihydroxy palmitic acid, from which Nagel and Harries, by reduction with hydriodic acid, could obtain palmitic acid itself.

The isolation of shellolic acid (m.p. 199-201°C) by Nagel was followed several years later by the isolation of an acid by Bhattacharya, ostensibly shellolic acid, but the melting point of this compound is only 90-91°C, and based on analysis, corresponds to $C_{15}\ H_{22}\ O_5$, instead of $C_{15}\ H_{20}\ O_6$ as given by Nagel and Harries. Later, Bhattacharya has isolated an acid identical with Nagel's shellolic acid. Work in this direction is necessary before the constitution of shellolic acid could be definitely established.

The American Shellac Bureau has gone a step further by the separation of certain fractions from the liquid resins, which give fairly sharp melting points. Their constitution is now under study, on the completion of which, attempts to build up the picture of a shellac molecule will have surer guidance.

The problem of the hardening of the ether-soluble portion of shellac is a very important one, as this will not only create a new field for itself, but will also make the use of hard resin (the ether-insoluble portion of shellac) technically feasible. The London Shellac Research Bureau has done a very important work in this respect by semi-technically separating by toluene extraction this hard resin which is mixed up with still a considerable proportion of the ether-soluble soft resin. An alternative method has been developed at Namkum which consists in treating an acetone solution of shellac with 6-8% of urea on the weight of shellac used. On keeping, the shellac polymerizes, *i.e.*, becomes insoluble and sets into a solid (this hardening of shellac by urea is the outcome of investigations at the Indian Lac Research Institute) which can be cut into small bits and powdered. The mass is washed once or twice with acetone, to remove the soft resin which does not suffer polymerization and the residue boiled with water, with the result that the hard resin is got back in a fusible and soluble form again. The mass is washed and dried, and can then be used for purposes for which the toluene extracted hard resin was used, with this difference that the hard lac obtained by the acetone urea method is practically free from soft resin, and has a much better appearance. The use of this variety of hard lac in the moulding industry is now being studied, whilst films on glass, copper and other metals have definitely superior character than straight shellac.

A very important outlet for shellac is in the French polish industry, but it consumes something like 15% of the total output of shellac only. Consequently a more suitable line of consumption for shellac is being sought in the building industry. Paints with shellac and boiled oils have already been investigated, which promise fair to be capable of being used as cement floor paints, distempers, etc. In London quite an interesting diversion of shellac has been proposed by its being condensed with linseed oil acids in the presence of glycerine and suitable catalysts. This work is in progress still, and its successful conclusion is being looked forward to.

The gramophone industry which is the largest consumer (about 40% of the total shellac) of shellac is now being constantly offered synthetic resins for their record-making, but as yet none has been found of quality and price to be able to replace shellac. Intensive research is necessary to retain this monopoly market for shellac, and efforts at Namkum are being directed to this end with a view to lay the foundation of a sound record industry in India. In the same line, the moulding of every-day articles out of shellac is being investigated, with the result that already passable samples of containers for cigarettes, powder box, pin trays, shaving soap boxes, etc., have been produced at the Namkum Institute at costs very much lower than those of synthetic-made commodities. Assemblage of proper machines and moulds are now under progress with the hope that an entirely Indian moulding industry on India's own raw materials may be realized.

From the commercial point of view the standardization of shellac is becoming an increasingly important factor, specially in view of standardised synthetics. Improved analytical methods, readily applicable to such examinations, have to be here and there developed. At Namkum reliable methods for estimating the adulterant, orpiment, in shellac and the determination of the unsaturation in shellac as a means of detect-

ing adulteration with rosin, are being developed. The present time-consuming method of estimating orpiment has been replaced by a half-micro estimation in specially constructed glass apparatus which could be used on the working bench without risk of fumes, three experiments at a time. The special feature of the digestion apparatus is its compactness and applicability to Kjeldahl estimation of nitrogen in organic substances, the noxious fumes of nitric and sulphuric acid being led away by a gentle suction of the water pump. In the development of a method for determining unsaturation in shellac, advantage has been taken of the mobile chlorine atoms of aryliodochlorides, $PhI{<}^{Cl}_{Cl}$ which removes the unsaturation in a much shorter time, yielding quite reliable results, specially in the case of fats and oils. The *inconvenience of preparing Wij's solution is thus* removed, as phenyl iodide is an ordinary laboratory reagent from which on simple chlorination in chloroform solution, the iodochloride precipitates in pure form. *The stability of the iodochloride solution in* glacial acetic acid leaves much to be desired, but it is stable enough to allow of estimations over a period of a week when fresh solution will have to be made. As already mentioned, the determination of extraneous moisture and water of constitution is an important problem, which is being tackled both in America and at Namkum, whilst a rational bleaching test to aid the suppliers and consumers is an important problem before shellac chemists. This has led to the working out of a process for manufacturing the best-quality seedlac which could be placed in the market as standard products and, indeed, might replace the manufacture of shellac in most instances. The process depends upon the washing out of colouring matters in shellac with the help of an alum solution in a centrifugal *machine, and so far, it has the promise of being* a technically feasible operation.

Research Notes

The Influence of Fertilizers on the Carotin and Vitamin C content of Plants

Carotene and vitamin C occur in vegetables as products of plant metabolism. It is therefore interesting to examine if the carotene and vitamin C contents can be influenced by soil treatment and particularly by fertilizers. For this purpose, J. B. H. Ijdo, (*Biochem. J. 30*, 2307, 1936) carried out an investigation to decide if the concentration of the elements necessary in plant growth had any influence on the carotene and vitamin C contents of the plant.

The investigations were carried out by means of pot experiments. In a number of the experiments the pots contained pure washed quartz sand, and in other cases an exactly analysed sandy soil, which besides K and P deficiency also showed a low pH. The pots were supplied with a salt solution, containing known amounts of $MgSO_4$, KCl, NH_4NO_3, $NaNO_3$, $CaHPO_4$ at pH = 7. 2. One or more components of this solution were omitted or administered in increased amounts so that by disturbance of the conditions of life an insight could be gained into the condition of the formation of vitamins in plants.

Spinach was used as a test plant, as it has the advantage of growing rapidly and containing considerable quantities of carotene and vitamin C. The plants were kept in glasshouse, the fullgrown plants were cut with scissors and only the leaves were analysed. Vitamin C was determined by the titration method and carotene by the Zeiss stufenphotometer.

Results of analysis show that the carotene and ascorbic acid contents of the test plants largely depend on the amounts of N and K in the soil. A larger amount of N results in greater carotene and vitamin C contents, whereas an increasing K content of the soil causes a decrease in carotene content and an increase in vitamin C.

The author concludes that N and K stand in close interrelation physiologically, K deficiency has the effect of N excess and K excess acts like N deficiency.

H. N. B.

A new fossil Skull from Eyassi, East Africa

Dr L. S. B. Leakey in an illustrated article in *Nature* (Dec. 26, 1936) has described the results of his preliminary investigations on the new fossil human skull discovered by Dr Kohl-Larsen in the course of a scientific expedition to the Eyassi Lake Basin in Tanganyika Territory in East Africa in 1934-36. Altogether, parts of three fossil human skulls were found associated with stone artefacts and fossil mammalian remains. Two of the skulls are represented by a small fragment of each, while the third, though discovered in a very large number of fragments, is capable of excellent reconstruction specially on the occipital and the left temporal region. The finds were discovered at the north east end of the Lake Eyassi and the fossils were exposed on the floor of the present lake basin, where they were held up by the recession of the waters during the dry season. Dr Kohl-Larsen noted three distinct strata and the materials were found from the middle one.

The associated fauna were all heavily mineralized and the extinct types include a few teeth of *Hipparion* and a few teeth of a baboon, apparently of the *Simopithecus* type, and some teeth of a large giraffid, a bovid of the Bubalus type, an antelope and a large carnivore. The fauna appears to belong to the Upper Pleistocene period. The stone artefacts belong to the Levallois type but a few broken Acheulean hand axes were also found along with many lumps of lava.

The importance of the discovery largely centres round the skull which, after the fragmentary pieces had been fitted up, was found to represent :-

(*a*) the greater part of the left parietal,
(*b*) the greater part of the occipital, and
(*c*) the greater part of the left temporal including the mastoid and petrous portions.

In addition several parts of the frontal bones were also found associated with two other fragments of the supraorbital region. The foramen magnum which is represented in part is inclined backwards at an angle comparable to that of the great apes and unlike any *Homo.* The skull approaches the greatest width about the mastoids like that of the *Sinanthropus pekinensis* and the latter is also approached in the massiveness of the torus. There is a fragment of the left maxilla, containing the broken sockets of the incisors, the left canine, and first premolar, and the broken socket of second premolar. A loose molar has also been found. The canine is of human form and there appears to have no diastema. A part of the right tymphanic plate (that of the left is broken away although the temporal bone of this is fairly complete) is remarkably like that of a chimpanzee. Dr Kohl-Larsen has thus discovered some extremely important and interesting remains of early man. The skull represents a low type of man with some marked anthropoid characters and approaches more the type represented by *Sinanthropus* than any other known human fossils. Dr Kohl-Larsen and Prof. Reck have attributed it to the genus *Palaeoanthropus* while Dr Leakey supports its place in a new generic rank. The skull, however, once again shows the association of the great Levallois-Mousterian culture complex with that human stock characterized by a massive torus and other specialized features uncommon to the *Homo Sapiens.*

S. S. Sarkar.

(*Continued from page 465*)

It is gratifying to learn that facilities for training medical students in psychological methods of treating mental cases have been provided in the hospital and that lectures and demonstrations are frequently arranged by the Superintendent for this purpose.

Dr Pacheco pleads for increased accommodation and a few more qualified nurses. It is an undoubted fact that the number of patients who have to go uncared for outside the hospital is far in excess of that receiving treatment in the hospital. We, therefore, fully support the modest and just demand that he has put forth and hope that there will not be any delay in sanctioning by the authorities concerned the extra expenditure that will necessarily be involved.

S. C. Mitra.

University and Academy News

Royal Asiatic Society of Bengal

A meeting of the Medical Section of the Royal Asiatic Society of Bengal was held on Monday the 14th December 1936 in the Lecture Theatre of the School of Tropical Medicine. The undermentioned papers were read.

1. D. N. Roy—Maggot treatment in surgical therapy.
2. L. E. Napier & R. N. Choudhuri—A Hospital case report.
3. Sundar Rao—The value of Fouadin in the treatment of Filariasis
4. B. Mukherji—Treatment of cyanide poisoning and the mechanism of action of antidotes.

Indian Chemical Society

An ordinary meeting of the Indian Chemical Society was held on Friday, the 20th of November 1936, in the Chemical Lecture Theatre, University College of Science, Calcutta.

Dr P. C. Mitter took the chair.

The following gentlemen were duly admitted, their subscriptions having been received for the first time:

1. Baradananda Chatterjee.
2. Narayan Chandra Sen-Gupta.
3. M. U. Parmar.
4. P. D. Swami.
5. K. S. Nargund.
6. N. N. Ray.

The following gentlemen were elected by ballot as Follows, Dr K. N. Bagchi and Rev. Father J. Van Neste acting as scrutators.

1. D. G. Walawalkar (Waltair).
2. Md. Abdul Saboor (Rajshahi).

Dr D. Chakravarti read the following paper in the meeting—Synthesis of coumarins and chromones. 4-chloro- and 4-bromo-1-naphthol and alkyl acetoacetic esters.

ANNUAL MEETING

The Thirteenth Annual General Meeting of the Indian Chemical Society was held on Wednesday, the 6th January 1937, at 2-30 p. m. in the Chemistry Lecture Theatre, Osmania University, Hyderabad, Deccan.

In the absence of the President, Prof. P. C. Mitter, one of the Vice-Presidents, took the chair.

1. The Chairman read a telegraphic message and a letter from Sir U. N. Brahmachari, the President, intimating his inability to attend the function and conveying his best wishes for the success of the meeting and his hearty congratulations to his successor.

2. The Chairman read the following nominations of the office-bearers, made by the Council.

President	...	Prof. J. C. Ghosh
Hony. Secretary	...	Prof. B. C. Guha
Hony. Treasurer	...	Prof. P. Neogi
Hony. Editors	...	Dr S. S. Joshi Dr A. C. Sircar
Hony. Auditors	...	Mr P. C. Nandi Mr T. K. Roy Choudhuri.

The Chairman announced the following names which have secured the maximum number of votes by ballot in the election as ordinary members of the Council for the respective areas.

Calcutta (3)	...	Dr P. K. Bose Dr Sudhamoy Ghosh Dr M. N. Goswami
Bihar & Orissa	...	Dr H. K. Sen
Bombay	...	Prof. K. G. Naik
C. P.	...	Dr A. N. Kappanna
The Punjab	...	Prof. S. S. Bhatnagar

U. P. (3) ...	Mrs Sheila Dhar Dr S. Dutt Dr S. Krishna
S. India (3) ...	Prof. B. B. Dey Dr B. L. Manjunath Prof. V. Subrahmanyan

Bengal (excluding Calcutta)—Dr S. S. Guha Sircar and Dr J. K. Chowdhury having secured the same number of votes, the Chairman gave his casting vote in favour of the sitting member, Dr J. K. Chowdhury.

3. The Hony. Secretary read his report for the year 1936.

4. The Hony. Secretary read the Treasurer's statement of accounts for 1936.

5. The Chairman announced that the Board of Examiners had recommended the name of Dr P. B. Sarkar for the award of Sir P. C. Ray 70th Birthday Commemoration medal.

7. (*a*) The Chairman announced the names of the following gentlemen as members of the Publication Committee for 1937.

Prof. S. S. Bhatnagar	Dr T. S. Wheeler	*Ex-officio.*
Dr A. N. Kappanna	Dr S. S. Joshi	
Dr J. N. Ray	Prof. B. C. Guha	
Dr H. K. Sen	Prof. P. Neogi	
Prof. V. Subrahmanyan	Dr A. C. Sircar	

7. (*b*) The following proposals of Dr M. S. Patel were considered :

(*i*) "The Indian Chemical Society should publish a News Edition of the *Journal* of the Indian Chemical Society 4 times in a year more or less on the same lines as the News Edition of the *Industrial and Engineering Chemistry* of the American Chemical Society in order to popularize Chemistry and its applications."

(*ii*) "That a new form of additional membership may be instituted in the Society such as the Junior or Associate member. These members can be enrolled on a payment of Rs 3 per year and will not be eligible for voting at the Annual General or local Meetings nor will they be entitled to the *Journal* of the Indian Chemical Society. They will, however, be entitled to the proposed News Edition of the *Journal*. The age limit for these members may be fixed at 18. No person above 26 will be allowed to remain or to be a Junior or Associate member. They may be allowed to elect one representative to the Council".

Dr. J. N. Mukherjee moved that the Council be asked to ascertain the financial possibilities of the scheme suggested by Dr Patel ; and in case the Council consider the scheme practicable they be authorized to take necessary steps in the matter.

The Chairman read the following resolutions of the Fine Chemical Committee.

"Resolved that a circular be issued by the Hony. Secretary of the Indian Chemical Society to Universities, Colleges, and Research Institutes requesting them to send copies of their indents for organic and inorganic chemicals for the last three years with quantities and price."

"Resolved further that a sub-committee consisting of the following, with power to co-opt, be appointed to consider the replies received—Prof. P. C. Mitter (convener), Drs M. S. Patel, B. C. Guha, H. K. Sen, and K. H. Hassan."

Indian Physical Society

The Third Annual Meeting of the Indian Physical Society was held in the Mathematics and Physics section room, Indian Science Congress, Hyderabad (Deccan) on the 6th January, at 11-30 a. m., with Prof. M. N. Saha (President) in the chair; a large number of fellows and visitors were present.

The President delivered an address on "Mission of Physicists in India" which was followed by a talk on Cosmic rays.

The report of the council for the year 1936 was presented and adopted unanimously.

The following were duly elected office-bearers and members of the Council for 1937.

President :–

Prof. M. N. Saha, Allahabad.

Vice-Presidents :—

Dr S. K. Banerjee, Poona.
Prof. D. M. Bose, Calcutta.
Prof. G. R. Paranjpe, Bombay.
Prof. H. P. Waran, Madras.

Secretary :—

Prof. S. K. Mitra, Calcutta.

Treasurer :—

Prof. P. N. Ghosh, Calcutta.

Members of the Council :—

Prof. A. C. Banerjee, Allahabad.
Prof. S. N. Bose, Dacca.
Dr B. N. Chuckervatty, Calcutta.
Prof. P. K. Datta, Benares.
Prof. K. Prasad, Patna.
Dr K. R. Rao, Waltair.
Prof. B. B. Ray, Calcutta.
Prof. N. C. Ray, Calcutta.
Principal B. M. Sen, Calcutta.
Prof. N. R. Sen, Calcutta.
Prof. J. B. Seth, Lahore.
Prof. M. R. Siddiqui, Hyderabad.

Calcutta Mathematical Society

The Annual General Meeting of the Calcutta Mathematical Society was held in the Society's room, on Sunday the 31st January, 1937, at 4 p. m.

1. The Annual Report of the Society for the year 1936 was adopted.
2. The Auditors' report for the year 1936 was considered.
3. An address was delivered by Professor N. R. Sen, D. SC., Ph. D., on "Mathematics and Realitiy."
4. The following papers were read :—
   - (a) H. Lebesgue. :—Sur certaines expressiones irrationnelles illimitees.
   - (b) E. T. Bell :—Numerical Functions of the Lattice points of $xy \ldots z < n$.
   - (c) C. V. Hanumanta Rao. :—On an analogue of Gaskin's theorem.
   - (d) R. R. Sharma. :—On Gaskin's theorem.
   - (e) J. G. Anand. :—On the inpolarity of a conic to a circle.
   - (f) A. Moessner :—Numerische Identitaten.

The undernamed gentlemen were declared elected as office-bearers and members of the Council for the year 1937.

President

Professor Syamadas Mukherjee.

Vice-Presidents

Principal B. M. Sen, The Hon'ble Sir S. M. Sulaiman, Professor C. V. Hanumanta Rao, Dr N. N. Sen, and Professor F. W. Levi.

Treasurer

Mr Satis Chandra Ghosh.

Secretary

Mr S. K. Chakravarty.

Other Members of the Council

Professor N. C. Roy, Dr S. M. Ganguly, Mr Ramaprosad Mukherjee, Professor N. R. Sen, Professor A. C. Banerjee, Dr P. L. Srivastava, Dr M. R. Siddique, Professor N. M. Basu, Dr C. N. Srinivasienger, Dr J. Ghosh, Dr R. N. Sen, and Dr S. C. Dhar.

Book Review

A Treatise on Heat (being the second and revised edition of a Text Book of Heat)—*by M.N. Saha, D.Sc. F.R.S., and B.N. Srivastava, M. Sc. The Indian Press Ltd. (Allahabad and Calcutta), 1935.*

The rapid progress of physics has not only induced revolutions in the world of abstruse concepts and abstract theories, but has also introduced novel methods, and achieved notable experimental results in all its domains. It thus demands a thorough revision of the methods of exposition of the subject in our text-books and in our class-rooms. A critical exposition of the recent experimental methods is now just as important as a clear presentation of recondite theories. The amazing developments in recent years have thus put almost all the earlier text-books out of date and the teachers and the young learners are often in very great difficulties in finding a suitable treatise which presents the newer acquisitions of knowledge in a logical manner and in their proper perspective, and establishes at the same time their connections with the classical results.

In no branch of physics, is this need more imperative than in thermodynamics and heat. One has only to think of the recent methods of specific heat mesurements or of the low temperature work, or again of the different statistical theories, to become immediately convinced of the demand of a modern treatise which will help the young students with the latest reference to all the important results achieved so far and serve at the same time, as a valuable guide through the mazes of the abstract theories.

The academic world, therefore, owes to Professor Saha a profound debt of gratitude for having revised his first edition of the *Text Book of Heat*. Almost every chapter of the earlier work has now been thoroughly revised and rewritten and brought up-to-date in his new *Treatise on Heat*. One has only to look through the contents to be immediately aware that here every aspect of this fascinating subject has been duly discussed and all the difficulties of the abstract theories have been sought to be removed by thorough and illuminating discussions of the fundamental assumptions. Professor Saha is a recognised master of the subject, and his long experience as an inspiring teacher, has enabled him to accomplish a task, which will win the admiration and gratitude of all his colleagues. This systematic and up-to-date treatise removes a longfelt want in the academic circle. May it prove a vital and fruitful stimulus to all the young aspirants of knowledge and induce fresh work and deeper investigation into the mysteries of nature.

S.N.B.

Triennial Report on the working of the Ranchi Indian Mental Hospital, Kanke. 1933-35.—*by Dr J. N. Pacheco. M.R.C.P., L.R.C.P., I.M.D., Offg. Superintendent. Price Rs. 1/4/-.*

The report reveals the valuable work done in the Indian Mental Hospital, Kanke, towards alleviating the sufferings of the mentally afflicted ones. In the three years under review the ages of most of the patients ranged between 20 to 30 years and the more frequent malady seemes to have been Schizophrenia and Dementia praecox. In the majority of such cases the critical period of adolescence and domestic worry were noted to be the prime conditions of the onset of the disease. Dr Pacheco is doing all he can to give relief to the unfortunate patients, and he has not failed to utilize in this connection the modern psycho-therapeutical measures. But the report should forcibly draw the attention of all concerned to the proper method of dealing with children during the critical adolescent period of their lives and to the necessity of reducing as far as possible the domestic worries. Psycho-analysis can help us a good deal in both these matters.

(*Continued on page 461*)

Letters to the Editor

Ephedrine Camphor Sulphonate.

The alkaloid ephedrine in the form of its salts is being extensively used in the treatment of asthma. But the drug has a considerable depressant action on the cardiac muscle and often[1] produces toxic symptoms such as nervous excitement, palpitation and insomnia. So a salt of this alkaloid with camphor sulphonic acid, the sodium salt of which is now being used as a vasomotor stimulant, has been prepared in the expectation of insuring a prompt response in emergencies of circulation and respiration.

A concentrated aqueous solution of ephedrine hydrochloride was made strongly alkaline with caustic soda (50%) solution and the base was extracted with chloroform. The chloroform solution was dried over anhydrous sodium sulphate and then treated with a molecular proportion of camphor sulphonic acid prepared according to Reychler[2]. Evaporating the solvent on a steam bath a syrupy residue that was left behind, soon set to a crystalline solid on scratching with the addition of few c. c. of petroleum ether. This crystallized from boiling ethyl acetate in fine silky needles, m. p. 173-174° sintering a few degrees earlier. A nitrogen estimation of the compound agreed with the formula $C_{10}H_{15}ON, C_{10}H_{16}O_4S$.

The salt is easily soluble in water, alcohol and chloroform, but insoluble in ether, ligroin or petroleum ether. A 6. 4% solution of the salt has a PH ca 5. 4.

U. Basu.

Research Laboratory,
Bengal Immunity,
Baranagore, Calcutta,
18. 1. 1937.

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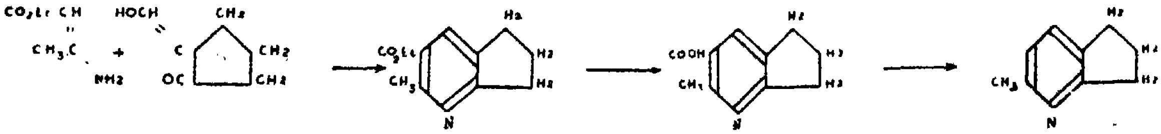
1. Chin and Schmidt, ***Medicine***, *9*, 1, 1930.
2. Reychler, ***Bull. Soc. Chim.***, *111*, 120, 1898.

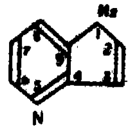
Synthesis of Pyridindene Derivatives.

A tautomeric compound of the ketimine-enamine type ($X.CH:CR.NH_2 \rightleftharpoons XCH_2.CR:NH$, where $X=CN$, COR or CO_2R group) has been found[1] to react readily with different hydroxymethylene ketones to give rise to various pyridine derivatives. Reacting now the hydroxymethylene derivative derived from cyclopentanone with a molecular proportion of ethyl β-aminocrotonate at 100° for several hours, an yellow liquid, b. p. 178-180°/ 25 mm has been isolated by extracting the reaction mixture with dilute hydrochloric acid and then neutralizing the acid extract with sodium carbonate. The oil on hydrolysis with 15% caustic potash solution gave a carboxylic acid separating from boiling alcohol as colourless needles, m. p. 208° (decomp). The acid when distilled with soda-lime afforded 6-methyl 2:3-dihydro-β-pyridindene (I) as an almost colourless, highly refracting liquid, b. p. 195-196°/ 750 mm. The course of the reaction is being represented by the scheme:

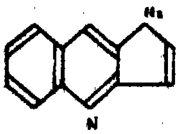


(I)

It is obvious that substituting ethyl β-aminocrotonate by similar other tautomeric compound the above reaction would afford an easy method for the synthesis of a new class of pyridine derivatives, β-pyridindenes. They are being regarded as derivatives of the hypothetic compound (II), termed β-pyridindene in analogy with the β-quinindene (III), several derivatives of which have been prepared by Perkin, Plant and others.[2]



(II)



(III)

The details of the work would be published in Leibig's *Annalen der Chemie.*

Research Laboratory,
Bengal Immunity,
Baranagore, Calcutta
3.2.1937

U. Basu.

1. U. Basu, *Annalen*, *518*, 131, 1934; *514*, 292, 1935; *J. Indian Chem. Soc.*, *12*, 289, 1935; Basu and Banerji, *ibid*, p 665 1935.

2. *J. Chem. Soc.*, p 639, 1928; p 1975, 1929.

Difference mass ($2H^2 - He^4$) calculated by Dis-integration data.

Aston's new mass-spectrograph data for the difference in mass between a deuterium molecule and a helium atom seem to be widely divergent from his older values and those of Bainbridge; and as Aston himself states that "his newer values are in better accord with the much more but less direct calculations from the energy relations in the equation of artificial disintegration" it seems worth while to compute this difference from a set of well chosen disintegration data. In our calculations reactions have been so chosen that the mass difference (*a*) ($2H^2 - He^4$), (*b*) ($H^1 + n^1 - H^2$) have been directly obtained or they have been obtained in combination. An accurate knowledge of these two quantities seems very fundamental in the precise determination of atomic weights by means of disintegration data.

$B^{11} + H^2 = Be^9 + He^4 + 8{\cdot}08 \pm {\cdot}15$ (1)[2]
$B^{11} + H^1 = 3He^4 + 8{\cdot}7 \pm {\cdot}2$ (2)[3]
$Be^9 + H^2 = Li^7 + He^4 + 7{\cdot}0 \pm {\cdot}2$ (3)[4]
$Li^7 + H^1 = 2\,He^4 + 17{\cdot}06 \pm {\cdot}06$ (4)[5]
$Be^9 + H^1 = Li^6 + He^4 + 2{\cdot}05 \pm {\cdot}1$ (5)[2,4]
$Li^6 + H^2 = 2He^4 + 22{\cdot}06 \pm {\cdot}07$ (6)[5,4]
$C^{13} + H^2 = B^{11} + He^4 + 5{\cdot}11 \pm {\cdot}01$ (7)[2]
$C^{12} + H^2 = C^{13} + H^1 + 2{\cdot}66 \pm {\cdot}02$ (8)[2]
$B^{11} + H^2 = C^{12} + n^1 + 13{\cdot}5 \pm {\cdot}3$ (9)[6]
$B^{10} + H^2 = B^{11} + H^1 + 9{\cdot}1 \pm {\cdot}1$ (10)[2]
$B^{10} + He^4 \doteq C^{13} + H^1 + 3{\cdot}5 \pm {\cdot}55$ (11)[7]?
$Li^6 + H^1 = He^4 + He^3 + 3{\cdot}6 \pm {\cdot}1$ (12)[4]
$H^2 + H^2 = He^3 + n^1 + 2{\cdot}8 \pm {\cdot}2$ (13)[8]
$Li^6 + n^1 = He^4 + H^3 + 4{\cdot}6 \pm {\cdot}2$ (14)[9]
$H^2 + H^2 = H^1 + H^3 + 3{\cdot}96 \pm {\cdot}06$ (15)[2]
$Li^7 + H^2 = 2\,He^4 + n^1 + 14{\cdot}9 \pm {\cdot}2$ (16)[4]
$Li^6 + H^2 = Li^7 + H^1 + 5{\cdot}0 \pm {\cdot}05$ (17)[5]
$Be^9 + H^2 = B^{10} + n^1 + 4{\cdot}25 \pm {\cdot}2$ (18)[6]

($2H^2$-He^4) is given by

(A) $(2) - (1) + (3) + (4) = 23{\cdot}44 \pm {\cdot}32$ MEV
(B) $(2) - (1) + (5) + (6) = 23{\cdot}49 \pm {\cdot}27$ MEV

($2H^2$-He^4) − ($H^1 + n^1 - H^2$) is given by

(C) $(7) + (8) + (9) = 21{\cdot}27 \pm {\cdot}3$ MEV
(D) $(9) + (10) - (11) + (8) = 21.77 \pm {\cdot}5$ MEV ?
(E) $(12) - (6) - (13) = 21{\cdot}26 \pm {\cdot}24$ MEV
(F) $(14) - (6) - (15) = 21{\cdot}32 \pm {\cdot}22$ MEV
(G) $(1) + (18) + (11) + (7) = 20{\cdot}94 \pm {\cdot}43$ MEV ?
(H) $(1) + (10) + (18) = 21{\cdot}44 \pm {\cdot}25$ MEV

($H^1 + n^1 - H^2$) is given by

(I) $(4) - (16) = 2{\cdot}16 \pm {\cdot}2$ MEV
(J) $(3) + (4) - (10) - (2) - (18) = 2{\cdot}00 \pm {\cdot}36$ MEV

(A) and (B) give practically the same value. The apparent discrepancy in their second places of decimal also disappears if the reaction energy in (5) is taken as the difference between (3) and (17). Thus the value of the term ($2H^2$ - He^4) is reasonably taken as ($23{\cdot}44 \pm {\cdot}32$) MEV. (I) and (J) give directly the value of the binding energy of the deuteron which has been provisionally taken as ($H^1 + n^1 - H^2$)$= 2{\cdot}17 \pm {\cdot}25$ MEV. The remaining six reaction equations include both the quantities (*a*) and (*b*), and give fairly concordant results when the errors in individual observation are made room for. Reaction energy in (11) is doubtful and seems very low. This reaction may be obtained as the difference of reactions (10) and (7); when the energy of release for this reaction becomes $4{\cdot}0 \pm {\cdot}1$ MEV. In that case (D) merges into (C); and (G) into (H). Miller[10], Duncan and May give the value of this reaction as low as 3·1 MEV. Cockroft[2] and Lewis are of opinion that this reaction cannot be regarded as satisfactory.

Reaction energy in (18) appears to be somewhat high, though Oliphant[4], Kempton, and Rutherford give a value still higher *e. g.* 4·9 MEV. If the value in (18) as given here is reduced by about ·17 MEV, the apparent high value for (H) and the low value for (J) disappears; and they agree to our values satisfactorily.

Reaction energy in (14) 4·6 MEV is apparently low as Chadwick[9] and Goldhaber suggested that the energy release is about 5 MEV. Disintegration value for Li^6 by slow neutron bombardment is given by Livingstone[11] and Hoffmann as $4{\cdot}67 \pm {\cdot}05$ MEV. With this value of energy release in (14); (F) approaches our value.

Energy release term in (16) has been decidedly given by Oliphant[4], Kempton, and Rutherford to be 14·9 MEV; which is found on calculation from their values of corrected masses. H. A. Wilson[12] also has given weight to this value. The value of 14·3 ± ·5 MEV given by Bonner[13] and Brubaker seems to be low.

The value of the binding energy of deuteron as calculated here by mass defect method seems to be probable on the basis of the photo disintegration experiments of Chadwick[14] and Goldhaber and of Feather[15], as also on the basis of the theoretical work of Bethe[16] and Pierls and others. Due to uncertainties in the energies of reactions involved in both (I) and (J) this value or the value for the mass difference of $(2H^2-He^4) = 23{\cdot}44 \pm {\cdot}32$ MEV cannot be asserted more definitely. The present value of the mass difference of deuterium molecule and helium is nearer to Bainbridge's value (23·4 ± ·2) MEV than to Aston's most recent value of (23·76 ± ·2) MEV. A check on this value of the binding energy of deuteron has been obtained by Bainbridge[17],[18] and Jordan's new mass spectrograph data of the mass difference $(N^{14}+H^1-N^{15}) = {\cdot}01074 \pm {\cdot}0002$ mass units combined with the mass difference of $(2H^1-H^2) = {\cdot}00153 \pm {\cdot}0004$ mass units; when the value of the binding energy of deuteron turns to be about 2·15 MEV. The value of $(2H^2-He^4)$ herein calculated lend support to the disintegration mass scale given by Cockroft[2] and Lewis.

Physics Department
Dacca University.
10. 2. 1936.

S. C. Biswas.

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   137, 357, 1936.
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4. Oliphant, Kempton and Rutherford— *Proc. Roy. Soc.* A. *150*, 241, 1935.
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6. Bonner and Brubaker—*Phys. Rev. 50*, 308, 1936.
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SCIENCE AND CULTURE

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AND CULTURAL SCIENCES
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APRIL 1937

Need of a Radio Research Board for India

Introduction

IT is only too well known that compared to other civilized countries of the world, India is deplorably backward in many matters of vital importance. The deficiency is nowhere more conspicuous than in those branches of national activity which depend directly or indirectly on the applications of modern scientific knowledge. In SCIENCE AND CULTURE we have repeatedly pleaded for greater application of scientific knowledge to various problems of our national life, *e.g.*, electrical development, irrigation and crop-planning, industrial progress, broadcasting, etc.

Like many other activities of a civilized society, India is hopelessly backward in broadcasting too. This will be clear from the fact that while the total number of wireless licences in force in Great Britain in August 1935 was about 7 millions, the corresponding figure for India was about 18,000 (March 1935). One promising feature, however, is that the number of listeners is rapidly increasing and the figure for March 1936 is estimated to be approximately 28,000. India is a vast country, and offers an enormous field for further progress. It is, therefore, hopeful that at last the Government of India seem to have realised the importance of broadcasting in national life.

In any branch of scientific activity, fundamental and intensive research work is necessary if continuous progress is to be maintained. In all civilized countries, the State as well as the private industrialists are well aware of this, and have fully equipped research departments for conducting the necessary investigations. In many cases, such scientific investigations can be carried out inside a laboratory, but research into the fundamental problems of radio communication can scarcely be limited in this way, since it is often necessary to collect scientific data from many parts of the world, and considerable resources and much co-operation are needed to stage the experimental work on an adequate basis. Such considerations as these have led to the formation of radio research boards, the first of which was formed in Great Britain in 1920, while others have followed in Australia and Canada. Recently the need of establishment of a national radio research board for India has been felt and discussed in various quarters. In SCIENCE AND CULTURE, June 1936, we have already published an account of a meeting organized by Prof. S. K. Mitra in London, in which a number of prominent British scientists had a discussion on the subject. Prof. E. V. Appleton, F. R. S., who was present, said that India had its own radio problems, the solutions of which depended upon workers in India. These cannot follow from work carried out in other parts of the world. It seemed to him that the formation of an Indian radio research board, in which workers in universities would be associated to encourage and extend radio investigation, was necessary to make certain that facilities for research were adequate. A wonderful opportunity for serving science and the country was offered to such a board and he felt quite sure that the opportunity would not be missed. Other eminent persons connected with the radio also gave support to the proposal.

The authorities in India are, however, apparently of the opinion that all the necessary research on radio problem in India could be very well undertaken by the newly formed research section of the All India Radio, and its organ, *Indian Listener*, in an editorial, gave expression to the same view. In a Letter to the Editor, (*Indian Listener*, Aug., 7, 1936), Prof. M. N. Saha pointed out several reasons why the research section of the A. I. R. cannot perform the functions of a national radio research board.

> "In the first place, the research section will be more concerned with immediate engineering problems of a commercial nature, and will not be able to undertake investigation of problems of a fundamental character, which is one of the main items in the programme of work of the Radio Research Boards. This is because the academic atmosphere which is necessary for the study of such problems is entirely in the research section of a broadcasting organization.
>
> Secondly, it has been our sad experience in the past that when a Government Department takes upon itself the task of carrying on fundamental research work, the duties of the officer engaged for the purpose very often begin and end in going through an interminable series of official files and the officer is hardly allowed any time for quiet thinking and sustained work; the desire of the Government to carry out such investigations ultimately reduces to a mere pious hope.
>
> Thirdly, it has not been found possible for the research sections of other and much bigger broadcasting concerns to take upon themselves the performance of functions of Radio Research Boards, and it will no more be so for the newly formed similar section of the A. I. R.
>
> (It may not generally be known that the British Broadcasting Corporation has a research section of which Mr. Kirke is the head. It deals with problems arising out of the technical development of the engineering of broadcasting and it has neither been within its scope, nor it has ever been its aim, nor indeed it is possible for it to perform the functions of the Radio Research Board)".

Nature has commented more than once on the desirability of establishing a radio research board for India. In an editorial (*Nature*, March 23, 1936), it was pointed out that broadcasting had a great future in India, and for its progress, all the scientific problems connected with radio communication in India had to be thoroughly investigated. Carrying out a comprehensive plan of research will be, however, beyond the means of anybody except a national radio research board. Again in a note in the News and Views section, *Nature* (Jan. 1937) confirmed the same opinion and expressed the view that the research section of the A.I.R., being more occupied with applied research, will not be able to act as a substitute of a radio research board.

Why India should have a co-ordinating body like the Radio Research Board

In connexion with the extension of radio communication service, problems of a local nature are met with in every country, the study and solution of which are essential for satisfactory progress of the intended extension or development. India is no exception to this rule. Such problems, for instance, are: Radio field strength survey, electrical properties of the soil, directions of arrival and field strength of atmospheres, allocation of the most suitable wavelengths for long- and short-wave broadcasting, etc. Apart form the local needs of broadcasting, various problems arise in connexion with Empire broadcasting for the solution of which a world-wide study is necessary. The data, for instance, regarding field strengths of received signals at different hours of the day, in different seasons of the year, on different wavelengths, and with differently disposed transmitting serial systems, and the angles at which the rays corresponding to such signals are incident at the receivers, are extremely meagre in India.

Problems enumerated above cannot be successfully studied by isolated bodies like universities (where only such study is now being carried on in India), working independently of one another. A co-ordinating body like the radio research board is essential for the purpose. The board should draw up a connected programme and allocate its items and the funds at its disposal to the various bodies which are willing to co-operate and have suitable men to undertake the study of the problems.

Results of investigations carried out on a comprehensive basis like this will, on the one hand, have immediate application to the solution of problems connected with the extension of radio service in India and, on the other hand, lead to fuller utilization of the Empire Broadcasting Service at Daventry, which aims at reaching every part of the Empire. Further, the results of the investigations, as a whole, will be of immense value to the progress of the science and art of radio.

Important research work connected with radio has been carried out at the University of Calcutta during the last ten years, on field strength surveys, ionospheric height and density measurements, influence of solar eclipse, etc. Ionospheric investigations are also being conducted at the University of Allahabad. These works have, however, lost much of their value for want of a proper co-ordinating body.

The benefits to be derived from a new organization of the type under discussion are best appreciated from a brief review of the work of those radio research boards which are already functioning.

Radio Research in England

In 1920 the Radio Research Board was established under the Committee of the Privy Council for Scientific and Industrial Research. The object was "to assist in the co-ordination of radio research work carried out by the fighting services and the Post Office and to provide for research work of *fundamental nature* in directions where it was lacking and where it was likely to lead to useful applications." In recent years the Board has ceased to be responsible for direct co-ordination of Government radio research and is devoting its attention mostly to the primary object for which it was appointed, namely, "to bring into direct relationship with the practical advances of the art of wireless signalling, physicists whose main interest in radio research had lain in work on the theoretical side and to place those concerned with the development of apparatus into closer contact with men of science well versed in the physical foundations essential for the satisfactory progress of the art."

The programme of research is:

1. Propagation of waves.
2. Atmospherics.
3. Directional wireless.
4. Thermionic valves.

The programme also includes research work of an international character, and the members of the Board and its Committees take prominent part, through the British National Committee, in the work of the Union Radio Scientifique Internationale.

In the Committee of the Board there are representatives of the Post Office, the B. B. C., the Admiralty, the Air Ministry, the War Office, the National Physical Laboratory, the Meteorological Department, and the universities.

The programme suggested by the Board is carried out partly in the National Physical Laboratory and partly in the university laboratories where there are facilities for undertaking radio research.

The funds are provided by the Department of Scientific and Industrial Research and by the Post Office.

Radio Research in Australia

A conference was convened in 1926 by the Council for Scientific and Industrial Research and was attended by delegates from the Postmaster-General's Department, the Defence Department, the universities, and the broadcasting interests. The conference gave the opinion that "the establishment of a Radio Research Board would be of advantage to all radio interests in Australia and that the primary function of the Board is to originate, facilitate, and co-ordinate radio research investigations." It further suggested that "such a Board could, with advantage, direct its attention to (*a*) co-operation with the British Radio Research Board and with the U.R.S.I., (*b*) consideration of scientific problems relating to broadcasting in Australia, and (c) the improvement of equipment and other facilities available in Australia for electrical measurements at radio frequencies."

The recommendations of the conference were accepted by the Council, as a result of which the Radio Research Board of Australia was established in 1927.

The programme of researches is :

1. Field strength measurement.
2. Heaviside layer and fading work.
3. Atmospherics.

In the personnel of the Board there are representatives of the universities, the Postmaster-General's Department and the Department of Defence.

A large proportion of the work is carried out under the auspices of Universities of Sydney and Melbourne. The funds are provided jointly by the Council of Scientific and Industrial Research and by the Postmaster-General's Department.

Radio Research in Canada

The National Research Council of Canada established an Associate Committee on Radio Research in 1930 with objects similar to those of the British and Australian Boards. The programme of researches is :

1. Atmospherics.
2. Measurements and Standards.
3. Wave propagation.
4. Direction finders and antennas.

The Department of National Defence is particularly interested in the study of atmospherics because it is hoped that by locating the sources of the atmospherics some added information can be obtained regarding the progress of storms. The information would be of use in meteorological forecasting and, consequently, of service to aeronautics.

In the personnel of the Committee there are representatives of the universities, the National Research Council, the Department of Marine, and the engineering and technical colleges.

The Committee works in co-operation with the following organizations : Canadian Marconi Company, Canadian Radio Broadcasting Company, McGill University, Northern Electric Company, and the University of Montreal.

The funds are provided by the National Research Council and the University of Montreal.

Some interesting features of the Radio Research Boards

The boards, while recognizing the importance of investigations having immediate practical applications, have not lost sight of the fact that, for real progress in the art of radio, researches of a fundamental character are extremely important. In fact, in most cases considerable stress is laid on fundamental work which should lead to a better understanding of the relation of geophysical phenomena to the propagation of radio-waves round the surface of the earth. For this reason close co-operation is maintained with the universities where men are available, who, by their training, are particularly fitted for such type of work.

Various Government Departments, like the Postal Department, the Defence Department, the Air Ministry, the Meteorological Department, and organizations like broadcasting corporations closely co-operate with the board's work.

A pleasing feature of the British Board—which is the first of its kind—is that it recognizes the Imperial aspect of the problems with which it has to deal and thus co-operates fully with the boards of the Dominion countries, not only by suggesting a common and suitable programme of work but occasionally by supplying them with the necessary apparatus.

The above account shows in short what has been done in the past in the direction of radio research in England, Australia, and Canada. India sadly lags behind, and we hope that steps will be taken in near future to create a radio research board in this country on the lines of those in England, Australia, and Canada.

Recent Progress in Nuclear Physics

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PHYSICAL science is at present passing through a remarkable phase of radical and revolutionary changes. Time-honoured concepts are crumbling down under the shock of remarkable discoveries. The familiar ideas of force, mass, and energy have undergone remarkable transformations and the dynamical laws which seemed at one time to provide the ultimate basis for the mechanical explanation of the material universe have now been replaced to a large extent by quantum-mechanical rules and probability-calculations. Controversy now rages round the validity of the very principle of causality without which science would have seemed impossible a few years ago. It is therefore not surprising that the old concept of the atom as the ultimate *indivisible* unit of a chemically simple stuff has been replaced by the modern idea of a complicated structure consisting of a positively charged material core, the nucleus, which itself in ultimate analysis appears to be heterogeneous, enveloped in a cloud of negative electrons, which again possess more or less definite amounts of energy and momentum, determined by quantum-mechanical rules.

The Electron and the Periodic Table

I shall endeavour in this brief discourse to present before you a brief history of the various experiments which have compelled the modern scientists to adopt this structure for the chemical atom in place of the familiar and simple concepts of Lucretius or of Dalton. The beginnings of the change in our point of view may be said to have been initiated about 40 years ago by the discovery of the electron in 1895. The experiments which led to its discovery established at the same time its presence as a universal constituent in all kinds of atoms. The intimate connexion between electricity and matter being thus established once for all, the subsequent endeavours of the physicists and the chemists have been directed towards explaining the divergent properties of the chemical substances in terms of electricity and electrical forces.

It will be obviously impossible in this brief compass to give an adequate account of all the results so far achieved in this region where physicists and chemists have worked side by side, and I shall therefore confine myself to a bare mention of the principal facts which have led the way to the modern conceptions about the atom. The ancient atomic theory was formulated mainly on the basis of chemical evidence. The analysis of innumerable substances, which either occur as such in nature or are artificially produced in the laboratory, has established the existence of about 92 simple substances, the so-called elements, whose atoms by combining and re-combining among themselves in various proportions have given rise to all the various substances we see around us. Without losing their individual distinctive features, many of these elements show among themselves remarkable similarities in their chemical properties. These have been intensively studied by the chemists, and the main results can be conveniently represented by arranging all the elements in a series of horizontal and vertical rows, in the so-called periodic table of Mendeljieff.

The remarkable feature of this arrangement is that whereas the atomic weights of elements increase steadily as we go down the series, marked similarities in the chemical properties recur at more or less regular intervals, *i.e.*, as soon as we come to elements which lie in the same vertical column of the rectangular array. The atomic number in the scheme plays as important or rather a more important role than the atomic weight of elements. No explanation of this regularity can obviously be found in the simple Daltonian theory. Nor was there any prospect from the chemical side alone of arriving at the explanation of the mysterious regularity in the chemical behaviour of elements.

The discovery of the electron however inaugurated novel methods of attack for the solution of the puzzle. The presence of electrons carrying negative charges, as constituent of all atoms, as well as the electrical neutrality of the atom as a whole, had brought the interesting question of the electrical structure of the atom to the fore-front. After the discovery of the electron the atom for the physicist could no longer continue to be a simple substance. The problem of its composition, *i. e.*, the distribution of mass and charge inside it, demanded an urgent solution, and speculations were at work regarding its structure even before adequate data were obtained for drawing probable conclusions.

Closely following on the discovery of the electrons, came the discovery of radium and the radioactive elements. Along with the familiar and stable elements which seem to persist unchanged through geological periods of time, the discovery of the phenomenon of radioactivity established the existence of the so-called unstable elements. Though these behave as ordinary elements in all chemical reactions, they are found to disintegrate spontaneously and give birth to new elements of smaller atomic weights, which in turn explode, regenerate fresh elements, and the series of elements of decreasing atomic weights is continued till the whole process comes to a stop with an element of ordinary stability at the end. During this process of successive disintegration the radioactive elements emit swiftly moving charged particles (the so-called α- or β-radiation). They also emit in general penetrating γ-radiations of the type of X-rays. The α-particles were early recognized as the nuclei of helium atoms which carry two units of positive charge whereas the β-rays were found to be swift electrons which move with velocities approaching the velocity of light. Though it was found impossible to control the phenomena of spontaneous disintegration of the elements, their very existence revealed the composite nature of at least the heavy atoms, and made the hypothesis of a structure for all atoms out of comparatively simpler substances a very probable one.

The swiftly moving positively charged α-particles, emitted during the process of radioactive decay, furnished the physicists with a very convenient weapon for attacking the problem of the constitution of atoms. Lord Rutherford conceived the brilliant idea of sending these swiftly moving charged particles as probing agents inside the atoms, where their mass and enormous kinetic energy would enable them to penetrate far into the mysterious interior, before they would be deviated out of their straight course by the intense Coulombian field of force.

The determination of the distribution of the scattered particles in various azimuths would, he hoped, enable the physicists to obtain a fairly correct picture of the distribution of mass and charge inside the atom. The first experiments in this direction were carried out in Rutherford's Laboratory at Manchester by Geiger and Marsden, and they at once afforded valuable information regarding the probable constitution of the atoms.

The physicists had already arrived at an estimate of the atomic size from various considerations. The kinetic theory indicated the radius to be about 10^{-8} cm. The experiments of Geiger and Marsden now revealed that the mass of the atom must be regarded as concentrated within a sphere of a much smaller radius, say (10^{-12} to 10^{-13} cm). This central core was also found to be positively charged, and its magnitude was approximately estimated at half the atomic weight of the element. This experiment of Geiger and Marsden enabled the physicists to form a fairly correct idea about atomic exterior. The planetary atomic model suggested by Rutherford, where a positively charged nucleus controls electrons revolving in orbits controlled by Coulombian forces, gained thus a universal acceptance among the scientists and proved a valuable and fruitful hypothesis. Detailed discussion of the subsequent developments will lead us too far away from our main theme. I shall therefore mention in the briefest of forms the principal achievements which we owe to this model. In 1913 Bohr showed that the optical spectra of elements could be explained on the basis of the above model if the electronic constituents of the atoms were supposed to move in definite orbits—determined mainly by electrostatic forces and by subsidiary quantum-laws. The study of the X-ray spectra of elements enabled Moseley at about the same time to settle with certainty the magnitude of the charge of the nucleus and also the number of electrons in outside orbits. The fundamental nature of the atomic number in the Mendeljieff's table received thereby a rational interpretation, and no interpolation, or change of arrangement in the series, could be conceived of at any subsequent period, as the sequence of atom in the table followed the integral sequences of increase of atomic charges. The idea of the spinning electron gave a rational explanation of the periodicities in the Mendeljieff's table. The electrons were revealed to be grouped in different closed shells round the central core and the chemical properties of the elements could be definitely correlated to the number of the electrons in the outermost incomplete shells. The elements of the same vertical column were found thus to have more or less identical external structure, which explained the similarities observed in their chemical properties.

Structure of the Nucleus

In 1925 came important theoretical developments. The modern wave-mechanics was formulated which enabled the physicists to replace the former tentative calculations by exact mathematical analysis and the different empirical procedures were unified into a single consistent analytical discipline. Though all the questions which have been raised by the study of the physical and chemical behaviour of elements may thus be said to have obtained more or less satisfactory solutions, the problem of the structure of nucleus had however been scarcely touched till the beginning of the present decade.

It is not difficult to find reason for this delay in the development of nuclear physics. The nuclei of elements lie hidden behind a protective cloud of electrons. The intensity of the Coulombian field also increases very rapidly by about 10^{10} times as we approach from the outside to the neighbourhood of the nucleus. The bombardment of atoms by swiftly moving electrons had not produced any fruitful results so far, and in order that positively charged particles could overcome the enormous repulsive force and approach the nucleus within a reasonable distance sufficient to produce significant perturbations in the nuclear regions and produce sensible results, swift particles with tremendous velocities appeared at first sight necessary, which were only available in small amounts from radioactive processes that continue yet to be beyond our control. The smallness of the nuclear size makes also the chances of close collision very very remote so that the percentage yield of any definite result by the bombardment of α-particles is very small indeed. Nevertheless since only the chemical properties of elements appeared to be governed by the nuclear charge, an artificial transmutation of elements could be hoped for, if one were able either to push a charged particle in the interior of the nucleus or to bring a charged particle in its immediate proximity, so that the disturbance thus set up might possibly induce spontaneous transmutation of the atom.

In order to ensure stability against the disruptive influences of the Coulombian forces, the presence inside the atom of attractive forces of unknown origin appeared also necessary. These attractive forces are most probably sensible at distances comparable with the linear dimensions of the nucleus, so that only a careful study of the large deflections of α-particles from single and close encounters with light atoms might be expected to give some information about the nature of these attractive forces. A successful carrying out of the above programme required the development of a special technique for the study of such atomic encounters. The early method of directly counting the scintillations to estimate the large angle scattering of α-particles as followed by Geiger and Marsden was further improved upon by Chadwick and Bieler in the laboratory of Rutherford at Cambridge. A direct measurement of the nuclear charge and an estimate of the nature of the electric forces acting on α-particles in the immediate neighbourhood of light nuclei were rendered possible by the study of scintillations produced by the scattered particle.

The expansion apparatus of Wilson supplied another valuable method of attack. Under suitable circumstances, the tracks of the colliding particles, the nucleus and the α-projectiles, before and after collision, could be directly photographed, and the interchange of momentum and energy between the colliding particles could be directly estimated from the measurement of stereoscopic pictures of such encounters. In case such collisions brought about artificial disintegration, the record of the explosion in the chamber photograph enabled us in many cases to follow the details of the process unequivocally.

The method of directly counting the scattered particles by the scintillations produced on screens has been replaced in recent times by simple, reliable, and automatic methods of counting the swift particles like α-particles or protons with the help of the Geiger Counter and proportionate amplifiers. The rapidity of advance during the last few years has been in large part due to the great improvements in the technical methods of attack.

Nuclear Disintegration; the Neutron

Already however in 1919 Rutherford had obtained by the simple scintillation method the first evidences of artificial disintegration. Nitrogen nucleus bombarded by *swiftly moving α-particles* appeared to give rise to streams of swiftly moving protons or nuclei of hydrogen, and subsequent work along the same direction had revealed the occurrence of this phenomena of artificial disintegrations during the bombardment of about twelve of the lightest elements.

By studying the phenomena of disintegration of nitrogen in a Wilson Chamber, Blackett was able in 1925 to give a satisfactory account of the details of the process. This nuclear reaction seems to arise out of a capture of the α-particle by the nucleus of nitrogen, whereby an H-particle escapes out of the nucleus and a new atom, an isotope of oxygen, is produced, according to the scheme

$$N_7^{14} + He_2^4 \longrightarrow H_1^1 + O_8^{17}$$

Two capital discoveries in recent years have revolutionized the subject and accelerated the progress of nuclear physics. Bothe in 1930 observed that beryllium when bombarded by α-rays from polonium gave rise to a markedly penetrating radiation which appeared to be of the γ-ray type. In a subsequent examination of this effect by M and Mme Curie Joliot in Paris and Chadwick in Cambridge in 1932, an important part of this radiation was found to consist of a stream of swift, uncharged particles, called neutrons, which have about the same mass as the proton. As it is uncharged the neutron does not directly ionize the gas in its path, but only reveals its presence indirectly by the recoil of the nucleus with which it collides. And since the transfer of momentum is largest when the mass of the colliding nucleus is about the same as the mass of the neutron, the secondary ionization by recoil, as produced in hydrogen or in paraffin-lined ionization-chambers, is much larger than in an ionization-chamber filled with a heavier gas. This peculiarity of behaviour has served to differentiate the neutron radiation from wave radiations of the γ-ray type, which also usually accompany the phenomena of neutron emission. Most of the nuclei of the light atoms also emit neutrons when bombarded by swiftly moving α-particles. This strange type of particles is in itself an important agent for effecting artificial transformation of other nuclei, mainly because it is uncharged and as such is not handicapped by the presence of the intense Coulombian forces. It can thus approach and penetrate into the nuclei of even the heavy atoms, and thereby bring out interesting transformations in novel ways about which I shall speak later on.

Potential Barrier

The perfection of wave-mechanical methods has induced various theoretical workers to apply the new ideas in problems of nuclear physics, especially in investigating the collision of charged particles with the atomic nuclei. The simultaneous presence of a Coulombian field of repulsion and an attractive force of unknown origin at short distances inside the nucleus gives rise to what is technically called the potential barrier. The intense attractive forces inside the barrier serve to keep the charged particles inside the nucleus. Beyond the distance where the height of the barrier rises to a maximum, the attractive forces cease to be sensible, and the field may be regarded as repelling charged particles according to the law of inverse squares. Any charged particle wanting to penetrate inside the nucleus will have to surmount the barrier, and according to the classical theory, it will have to have a kinetic energy sufficient to come over the top of the barrier.

Based on arguments similar to the above, one estimated (before the advent of the wave-mechanics) that *a minimum acceleration-potential of a few* million volts would be necessary to produce sufficient acceleration in particles, before they are able to cross the barrier. This estimate however proved erroneous and excessive.

A noteworthy contribution of the theoretical physicists *(recent wave-mechanics)* in this subject has been to predict a small but appreciable probability for penetration of protons across the barrier of light elements, even when they have energies of the order of a few hundred thousand e.volts. The prediction seemed to bring artificial transmutation on a large scale within the range of possibilities, and this theoretical conclusion was tested experimentally by Cockcroft and Walton in 1932 who had been able to generate a proton stream of about 100,000 volts, in a vacuum tube, by step-wise acceleration. Their experiments at once met with complete success and the evidence of disintegration of the lithium nucleus subsequent to the capture of a proton was obtained by bright scintillations produced on the screen by the α-particles that were generated by disintegration. This initial success of the Cambridge physicists has been followed up by other workers in Germany, France, and America, and it has become clear that considerable progress in artificial disintegration can be achieved by bombarding elements with swiftly moving protons and other nuclei accelerated suitably by application of high voltages. Investigators of nuclear physics have concentrated their energies on the production of suitable high voltages, and notable success in this direction has been achieved in recent years. Three different methods have been mainly followed in producing the necessary high voltage: firstly, the original method of Cockcroft and Walton, which consists in accelerating the particles in the vacuum tubes in stages with suitably insulated transformers; secondly, the method of Lawrence, who has developed a peculiar method of multiple acceleration of ions in a synchronized magnetic and electric alternating field; and thirdly, the electrostatic method of Van de Graaf. Considerable progress has been achieved by the application of all the three methods and a lot of interesting results have been obtained by the bombardment of atomic nuclei, by suitably accelerated projectiles. I have already mentioned before the production of neutrons from the light elements by the bombardment of α-particles. Results of great significance were obtained as soon as these particles were used by workers in nuclear physics. In curious contrast with the swiftly moving α-particles and the artificially accelerated proton streams, and other corpuscular rays, the capacity of the neutron to produce artificial transformations increases, in most cases, with the diminution of its velocity. Doubtless this is connected with the fact that its small velocity enables the particle to stay longer in the immediate neighbourhood of the nucleus and thus to bring about more far-reaching changes.

Induced Radioactivity

It has been established by the work of Fermi and other members of the Italian school that a few collision of neutrons with hydrogen nuclei (present in either a free or a combined state) are sufficient to establish a sort of thermal equilibrium, so that the neutrons on the average attain, after a few collisions, the average velocity of hydrogen particles at room-temperature. Whereas the transmutation of elements to stable varieties of other elements had been previously noticed or conjectured, during the bombardment by α-particles, or protons, Curie and Joliot discovered in 1933, that unstable and hitherto unknown isotopes of light elements are produced by the bombardment of light nuclei with α-particles. These unstable nuclei subsequently break up in the same way as ordinary radioactive elements, and phenomena of induced radioactivity are found to obey the same laws, and decay in the same characteristic way as the natural activities of the well-known radio-elements. The identity of these artificial bodies can also be often established by purely chemical methods. In their pioneer work Curie and Joliot discovered that unstable isotopes of nitrogen, silicon, and phosphorus are formed by the bombardment of Be, Al, and Mg: these however emit, curiously enough, positive electrons though the phenomena of disintegration proceeds like the familiar β-ray disintegration of radioactive elements. The discovery that new radioactive elements can be produced by artificial transmutation has given a tremendous impetus to the study of the nuclear reactions. The task of following such nuclear changes is a very much easier one, as sensitive physical apparatus like the Geiger Counter can be utilized to detect and measure such changes. This pioneer work of Curie and Joliot has been greatly extended by Fermi and other workers in Italy. They have observed that slow-moving neutrons are in most cases quite effective in producing similar changes and of generating radioactive isotopes. Extensive work in this line has been done and a large number of new radioactive atoms have been discovered. These however almost always emit β-particles, *i. e.*, ordinary negative electrons instead of positrons.

Deuteron—the Isotope of Hydrogen

With the discovery of deuterons, the isotope of hydrogen, a new kind of corpuscle has been utilized for bombardment of atomic nuclei. Accelerated deuteron streams have been utilized both in England and America and they have proved very much more effective as agents for transmutation than the original proton rays of Cockcroft and Walton. Bombardment by deuterons also produces radioactive bodies and this method has been increasingly used in recent times to study the phenomena of induced radioactivity. The earlier methods of production of new radioactive bodies had to utilize a natural radioactive source for the supply of the suitable bombarding agents; this had necessarily limited the amount of the yield even when the process of canalization was utilized for diminishing the velocity of the neutrons and thereby to bring about an enormous increase of output. The yield of radioactive stuff by the bombardment of deuterons has been naturally very much greater. For example, in a day's exposure a yield of radioactive isotope of sodium has been reported to have been obtained by Livingstone whose activity equals that of 1 gramme of radium. Deuteron bombardment has therefore a great future both in the therapeutical application of radioactivity to medical research as well as in the investigation of nuclear problems.

Whereas bombardment of corpuscles has been almost always utilized for producing nuclear changes, results similar to photo-ionization have been obtained by Chadwick and Goldhaber. By utilizing hard γ-radiation from ThC these investigators have been able to decompose the hydrogen isotope into neutron and proton. The liberated neutron can be detected by its ability to produce induced radioactivity in suitable elements, or by a properly conducted ionization measurement. By hard X-rays emitted in tubes run at more than 1.5 million-volts pressures, the workers in Berlin have been able to eject neutron streams from beryllium, whose presence has been similarly demonstrated by the generation of radio-iodine in ethyl iodide. These preliminary results have great theoretical significance; Chadwick has been able from a tentative determination of the thresh-hold value of the frequency of the γ-rays necessary to decompose deuterons, the mass of the neutron as well as the strength of the binding of the two fundamental particles.

Conclusion

In this lecture I have attempted to give a rapid review of the principal results obtained in the field of nuclear physics in recent times. I shall conclude my remarks by mentioning two remarkable results that have been obtained by the bombardment of thorium and uranium, the two heaviest of the elements with neutrons. I have already observed that the production of new radioactive bodies could, in many cases, be proved by chemical methods ; this serves at the same time to determine the chemical properties of the new substance, and its position in the periodic table. By the bombardment of uranium, Fermi originally reported the production of new β-ray emitting elements whose chemical behaviour seems to point to their positions beyond uranium itself in the Mendeljieff's table. This has been corroborated by Meitner. According to these workers the table of elements is *artificially* extended by this process beyond uranium itself—according to the scheme

$$U_{92}^{238} + n_0^1 \longrightarrow U_{92}^{239} \xrightarrow{\beta} \text{Eka Rhenium } ER_{93}^{239} \longrightarrow \text{Eka } Os_{94}^{239} \longrightarrow \text{Eka } Ir_{95}^{239},$$

a truly *remarkable* result.

By a study of the product of the disintegration of thorium by neutron bombardment Curie has established the existence of a new series of radioactive elements whose mass numbers are in the form $4n + 1$. This analogous series of radioactive bodies is not known in nature, and its discovery can be regarded as completing our ideas of radioactive disintegration of heavy elements.

It will be evident from what I have reported above that enormous experimental materials have accumulated in the field of nuclear physics within recent years. Sufficient materials are now available for the theoretical physicists to speculate about the process of atom-building from elementary particles, and the preliminary work in this direction has already begun. The neutron and the proton seem to be the two exclusive constituents of all atomic nuclei. The α-particles can themselves be looked upon as composite bodies, built up again from neutrons and protons.

Though the idea of the elementary atom has undergone revolutionary changes in recent years, in a certain way the progress achieved has been satisfactory, as it has simplified the number of ultimate and fundamental particles to only two, instead of the 92 elements of the older atomic theory. This idea of the evolution of the material world from comparatively few primordial stuffs is not however new. Here, as in other fields of physics, old ideas have returned, renovated in a new garb and clothed with more significance. The quantum theory of photons has to a certain extent resuscitated the ancient corpuscular theory of Newton. The recent developments of the nuclear physics have brought back the old Proutian hypothesis, of the evolution of all elements from one or rather two primordial stuffs—the proton and the neutron.*

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The Organization of Village Societies

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IT has always been recognized that villages are the fundamental social units of an agricultural country like India. Our attempts at the reconstruction of society, economic, social, and political reforms, must therefore be based on a scientific knowledge of the structure and organization of our villages and the reality of village life. The object of this paper would be to suggest a method of inquiry into these questions.

A social unit has an internal organization and structure. It is also related to other social units, so as to integrate into higher and larger units. Both these organizations—internal and external—are supported by what may be called social forces of cohesion. *Objectively, these forces are manifest in* a number of customs and institutions. And social integrity and cohesion are maintained by the observance of socially approved types of conduct by every individual member of the society. Social cohesion therefore depends on individual conformity and those psychological factors in the individual which produce this conformity.

It is possible to form a theoretical estimate of these forces by a study of individual and social psychology. But for our purpose it will be better to confine our inquiry to the institutions and customs which lend themselves to a more direct observation and an objective study. If necessary, it will be possible to deduce the psychological element behind social conduct from the study of conduct itself.

There is one thing, however, which must always be remembered. This is the part played by tradition in each one of our customs and institutions. It is this which gives a peculiar sacredness and a compulsive force to social customs. And no study of society at the present day can afford to ignore the background of tradition.

We want to arrive at a general idea of the structure and life of our village societies. This generalization can be obtained only by a comparison and collation of results obtained in different villages.

The method of comparison must however differ from some of the usual comparative methods of sociology which split up culture into its various elements and then proceed to draw a comparison between similar elements from different fields of observation, isolating them from the rest of their cultures. For our purpose we must examine the whole culture and life of each individual village and the question of inter-relation between its different aspects, and it is only after we have done this that we can proceed to a comparison between different villages. For what we are seeking to know is a village in *the wholeness of its social life.*

In examining the internal structure of a village, we shall probably find forces which support its unity—and possibly other forces that go contrary to this by setting up loyalties to other units and organizations like caste, community or economic classes.

In examining the integration of villages into other units, we have to take account of those communities of villages which are associated together by economic and genealogical ties and possibly by the incidents of local history. We may again find that some of these integrative forces, while they build bigger social units, really undermine the unity and social authority of the component village units by placing them elsewhere. Our study must therefore examine the equilibrium and balance of these contending forces.

Our central theme will then be the organization and significance of village units and their relation with similar units. But other interesting things will come the way of the observer—the problems of special classes, the peculiar customs of various castes, and so on. Their interest must however be subordinated to the general problem of the inquiry and they must be examined so as to answer this question

—How far do they support the unity and reality of village life?

The *primary inquiry* in village centres will have to be carried out by a number of observers. The best people to do this will be university students, who could do it at their own villages during a long vacation.

The main questions they will have to deal with are outlined below. But it is by no means an exhaustive summary. Many other questions will suggest themselves and may be added to the list, so long as they are within the general framework of the inquiry.

An important preliminary to the inquiry into present conditions will be a short summary of the local history. This is not because we are thinking of trying to trace the evolution of social customs, but because it will help us to understand the forces of tradition that influence the villagers at the present day. Formal history of events will be less important than the history of the more important families of the village and of religious institutions and endowments. On the other hand, all the traditions and stories about villagers who have lived in the past—traditions which still seem to be significant to the villagers themselves—even if not truly historical, will be important. It will also be necessary to give an account of the village's past affiliation to administrative and revenue units, old zemindaries and perganahs, and so on.

Coming to the village as it is in the present, the first question that arises is how far the village is a territorial unit. It will be interesting to see whether the village has any boundaries that are generally recognized and how and when these boundaries were fixed and whether the boundaries are purely artificial or correspond to local topographical features like rivers, canals, roads, or forests, or even prominent and old trees. The territorial features inside the village boundary have next to be examined and the question how homesteads and agricultural lands are distributed relatively to each other. There are several possible types. In some villages it will be found that each homestead has its adjoining agricultural lands. In others the homesteads will cluster round one part of the village and there will be agricultural lands elsewhere. In some others the homesteads will have attached horticultural plots while the agricultural lands will be elsewhere. The next question will be the situation of various special places that are important for the village life—the village market, the temple and the mosque, the cremation ground and the burial ground, the village play-ground, if any, the common pasture and fallow lands, the village school, and so on. The next question will be that of the territorial distribution of the various castes and communities in the village, whether any of them occupy any definite and separate area within the village. The constitution of the sub-divisions of the village, the hamlets (*pallis*) and the significance of the names given to them—they are very often named after a particular community or caste—will have to be examined. There will be other places important for the communal life of the village—tanks where people come to bathe and talk, trees under which they sit together, village halls where communal worships are held (*Barwari-talahs*), trees which have village deities attached to them, and so on.

The next aspect of the territorial organization will be the land system—whether any of the villagers hold or cultivate land outside the village area and correspondingly whether any from outside the village hold and cultivate land inside the village boundary. The places of residence of the local landlords (zemindars and important jotedars) and the situation of collection centres (*kutcheries* and *tahsils*) and their distance from the village will also be important. All this will illustrate the territorial organization of the village and can best be described by a sketch map. An account will also have to be given of the means of communication to and from the village, and the places with which it is so connected.

The next question will be the genealogical relations within the village and its connexions with other villages. This will mean an examination of the relations by blood and marriage between the different families in the village and how far their marriage ties have extended beyond the village itself. There will possibly be families which have emigrated to the village from somewhere else and have traditions of this emigration. It will be necessary to see how they have done in the way of establishing relations by marriage with other villagers or whether they persist in their relations with their old homes. It may also be found that a number of families related to each other or of the same caste have emigrated to the village from somewhere else and have restricted their marriage relations within the small group. They will thus have preserved the identity of their sub-community within the village community.

Having thus obtained the territorial and genealogical constitution of the village, we shall next have to see in what forms the village expresses its corporate unity of life. Communal worships (*Barwari pujahs*), fairs and *melas*, religious festivals where all the villagers join, village athletic clubs and amateur dramatic societies, will all give an indication. It should be remembered that the corporate life of a social group as a group very often lies dormant and without a concrete expression except on special occasions. These may be social functions or a time of crisis and danger for the whole group. These occasions should therefore be investigated and described. Sometimes it will be found that the whole community is interested in and makes common cause of an occasion which directly affects only an individual or a single family. Crises in an individual life, like birth, marriage, and death, draw in all the members of his family and to a certain extent the members of larger groups, and the ceremonies or the *rites de passage*, as they have been called, reflect the solidarity of the group. This will be more particularly the case when the family in question is that of the landlord or some other important person. In many cases it will be found that the expressions of village solidarity takes the form of rivalry with a neighbouring village—as in village sports or boat races in riverine districts. Cases of co-operation in corporate activities with other villages may also be found.

Evidence of the corporate entity of a village may also be found in the mechanism of social and judicial arbitration. Where councils of village elders or *Panchayets* exist this will be quite obvious. But it will be necessary to see on what principle these councils are constituted and what kind of disputes they are called upon to settle. The councils may be permanent bodies comprising of men chosen for their respectability or rank or age, or they may be *ad hoc* bodies coming into being when each individual dispute arises. In this case they may either be chosen by the parties to the dispute itself or by a consensus of opinion of all villagers. Their function may also vary to a considerable extent—they may be restricted to purely social questions like the propriety of marriages or the breaking of a food taboo, or their function may extend to the decision of disputes about money and property, subjects which also come within the jurisdiction of formal courts of law. It will be necessary to find out if arbitration within the village is at all an important thing at the present day.

Then again, it may be found that the mechanism of arbitration is closely connected with the caste organization. It will possibly be found that some of the castes—especially those which are supposed to be lower down in the scale of caste hierarchy—have their own caste *panchayets*. It will again be necessary to see how far these are permanent organizations or *ad hoc* bodies and what sort of questions they are asked to settle—also whether the caste organization is restricted to the one village or takes in members of the same caste from other neighbouring villages also. Where there are both a caste council and a village council it will be necessary to see what the relation between the two is and whether the caste organization has in any way a subordinate authority to the village council.

In some cases no council or *panchayet* will be found but one or two individuals who, by general agreement, have been given a certain amount of social and judicial authority. It may be the local landlord or his agent, or the village *Mandal* or some village elder. It will again be interesting to note the principle of selection and the extent of authority, especially about the position of the village Mandal, and whether the office is hereditary, or elective, or based on appointment by the landlord, and what other functions the Mandal combines.

In this connexion it will be useful to examine the position of the statutory Union Boards or village *panchayets* and to see how far the basic idea of the Village Self-Government Acts, that is, the revival of village authorities, has been successful in its actual working. We shall have to see if the Union Board plays any large part in the corporate life of the villages and if many disputes are referred to the Union Courts and Benches. Also another thing, it is possible that the recent nationalistic movements have given an impetus to the formation of authoritative bodies in the villages. I remember that during the first days of the Non-co-operation Movement a powerful organization based on caste-*chhatrisi* or the thirty-six castes, as it was called, was formed in various parts of the Malda district, and this organization went to the length of controlling the prices of commodities sold in the markets.

About different castes and their customs, though interesting, the organization of individual castes is not really very relevant to the central subject of our inquiry except in so far as its relation with the organization of the whole village goes. It may however start the observer on another and a very fruitful subject of investigation. If he does so, it will be best for him to confine his attention to a particular caste in one village and examine the whole of its customs and organization and not to go in for a comparative or historical method. In other words, he must do for the particular caste what he is doing for the entire village. But if there is in the village a community belonging to an aboriginal tribe like the Santals, Oraons, or Mundas, as there is in some parts of North and West Bengal or other communities who have emigrated from North-west India, it will be necessary to see in detail how far these people have assimilated the culture of the village community and share the corporate life of the village.

The same remark applies to the question of religious communities. While on the one hand we need not go at any great length into the details of their mode of life, at the same time we must go into the question of their inter-relations, their co-operation and conflict. The observer must here be very careful, for it will be very easy to be carried away from a strict scientific method by any possible communal bias. But it is necessary that we must go into any possible reality that may exist in village life behind what is called the communal problem, and an account must be given of both of the positive side of co-operation and the negative side of conflict. It will probably be found that Hindus and Muhammedans still observe some social and religious ceremonies together and join in festivals. It will not be impossible to find a Hindu promising an offering to a Muhammedan shrine or a Muhammedan promising a similar offering to a Hindu temple or deity. To give a concrete example from Central Dinajpur, I found a village with an exclusively Muhammedan population. But the village as a community had a gift of rent-free lands endowed in the name of a Hindu deity. An old stone image of Vishnu was to be seen in the outskirts of the village near an old tank. The Muhammedan population looked after this place and once every year called a Brahmin priest for the worship of the image and paid for it from the income of the rent-free lands. In some of the neighbouring villages I very often found a Hindu Mandal or family in charge of rent-free lands or "Pirpal" endowed to a Muhammedan shrine. In another village I found rent-free lands allotted to the descendants of a Muhammedan mason, who had worked on a Vishnu temple founded by the Maharajah of Dinajpur about 350 years ago. Facts similar to these, where observed, will be interesting and important. There will again be some village customs and ceremonies—mostly connected with agriculture and harvest and associated or not with religious beliefs—which are observed equally by Hindus and Muhammedans, it may be with slight variation in details. All over the north of Dinajpur district, for example, I found a custom, common to Hindus and Muhammedans, of tying a banana leaf round fruit trees on Lakshmi Pujah day for increasing fertility. While facts like these are important, it will be necessary, on the other hand, to examine the concrete cases of communal conflict that have arisen in the village during recent years, and to see whether there was any thing in the organization of the village itself which was responsible for these conflicts or whether they were due to causes external to the village itself. It is only after examining questions like these that we shall be able to understand the true nature of that communal question which has become such a large issue in our national life.

There will be another community, which will possibly require investigation in some detail: the Christian converts, where they are found. The most relevant point will be to see how far their conversion has removed them from the framework of the village organization and how far their life is peculiarly their own.

We must now pass to another large aspect of the village organization—the economic aspect. The points that must be noticed are these: How far the village can be called a self-contained economic unit, whether it depends on any neighbouring village for any special class of commodities or crafts and on the other hand whether the village under inquiry supplies the neighbouring villages with any special commodities or craftsmen, how neighbouring villages are organized as a community through chains of market or *hats* and whether the different castes in the village still have definite professions or trades attached to them. Apart from the interchange of commodities between neighbouring villages, it will also be necessary to see if there is any interchange of goods with more distant parts. In many of the North Bengal districts, especially near the Padma, it will be found that traders from Upper India visit the villages in boats, bring stone-ware, and take back paddy or other agricultural products. In some East Bengal villages similar interchange will be found between local produce and lime from Sylhet in Assam. In some parts again it will be found that people from distant districts have settled in the village and trade in particular commodities. In a small island off Cox's Bazar in Chittagong I found a fairly large population which had emigrated from the district of Nadia and was the exclusive grower of betel leaves. A similar emigrant population from Nadia was found in a village in the interior of Rangpur district. They traded in conch-shells and conch-bangles. People from Cutch have now been residing in the interior of Rangpur district and are dealers in tobacco. Itenerant traders and emigrants like these bring a number of social influences into the village community, which require examination. On the other hand, it will be necessary to know how many people from the village have moved elsewhere for finding work, whether they have taken their families with them and what sort of relation they continue to maintain with their old village homes.

Questions like these may be multiplied. But it is impossible to deal in this paper with all the aspects of village sociology that can and should be examined. But the points enumerated above will probably give an indication of the general scope and nature of the proposed inquiry. Apart from his own observations, the worker may very well draw upon village records that he may find with the Mandal of the village or the local landlord. He will probably also find the record and statistics of Settlement operations helpful to him. The workers must try to give as full an account as they can of their villages as a corporate social unit and their relation with similar units in the neighbourhood. And the later comparison and theoretical work have to be based on their accounts.

Lignin

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HEUSER in his treatise on cellulose says, "If the constitutional formula of cellulose were known, the chemistry of cellulose could be written in a few sentences". The same is equally true in the case of lignin. Scientific investigation on lignin began a century back, with Payen—a Frenchman, in the year 1838, *i.e.*, only 10 years after Wohler's synthesis of urea, or one might say, the birth of organic chemistry. Since then nearly 400 chemists have engaged themselves to elucidate its nature from different points of view. As a result, we are in possession today of a large volume of experimental facts which are as difficult to co-relate as to discard. The structural formula of lignin remains as shrouded in mystery as ever. We all know what wonderful and rapid progress organic chemistry has made since 1828, but unfortunately lignin chemists have been able to proceed only a few short steps towards their final goal. Our present-day knowledge of lignin, to speak the truth, really consists of a large number of experimental observations only, some of them quite contradictory, many of them very peculiar, and not a few extremely difficult to fit into any formula. I shall deal here only with those facts which throw or tend to throw any light on its constitution. A very appreciable number of them, it will be found, have served to confuse issues rather than clarify them.

The word "lignin" is derived from the Latin "lignum" which means wood. This is because it is a common constituent of all kinds of wood. The percentage however varies between wide limits—from 15 to 30%. This is an organic component of the cell wall—its function is to increase the strength of the wall. At one time it was defined as the non-polysaccharidic portion of the cell wall but this has been challenged by some investigators. Some workers tried to differentiate it as the aromatic portion of the wood but others advanced contradictory views and it was dropped. The attempts to define lignin by colour reactions have proved futile—they are too many and none can be explained chemically. Moreover, no sample of isolated lignin has yet been found to give any of the colour reactions. As a matter of fact, even after 100 years of research, we cannot give a sharp clean-cut definition of what we actually mean by lignin. We have no criterion of purity of lignin. It has no melting point. But it is a fact that when we can define a thing correctly, we know practically all about it. We can define it in a negative way—lignin is not cellulose, neither it is fatty or resinous matter, nor like pectin.

In wood and vegetable fibres (except, of course, cotton, which is practically pure cellulose), the principal portion is cellulose—being about 60%, next comes lignin. Then we have small amounts of fatty and resinous matter, moisture, pectin, some inorganic salts and also some protein matters. All these together make wood. Grass freed from lignin —or delignified gives paper pulp ; so does bamboo. In making artificial silk, woody matter has to be delignified. In the preparation of laquor varnishes as well, lignin has to be removed before nitration or acetylation. Thus we see, in industry we are more concerned with the removal of lignin—it is an undesirable body.

There is difference of opinion regarding the state in which lignin occurs in ligno-celluloses. According to Lange (*Z. Physiol. Chem*, *14*, 15, 1889), lignin exists in chemical combination with cellulose and the linkage is of an ester type. Hoppe-Seyler regards it as an ether. In any case, the only reactive groups in cellulose are the OH which are supposed to take part in the combination. He regards the occupation of the OH groups in cellulose by lignin through combination, the experimental evidence so far put forth is not convincing. Sen and coworkers acetylated water hyacinth exhaustive'y but only two OH groups out of three in the cellulose unit could thus be acetylated. It is said that the third is occupied in combination with lignin. After removing lignin, the third OH can be easily acetylated but not before. But according to Fuchs and Horn. lignin as it occurs naturally in wood, can be acetylated so that the product appears to contain 3 acetyl groups in excess of those present in acetylated Willstätter lignin. It is indeed difficult to co-relate these two contradictory facts.

Lignin isolated under the mildest possible conditions is insoluble in all known solvents. So its easy separation by means of solvents is out of the question. Cross and Bevan, König and Rump hold that cellulose and lignin exist side by side without any chemical combination. It has been suggested by Wislicenus that cellulose merely adsorbes lignin. Clark has shown that lignin present in wood is essentially amorphous in giving X-ray defraction patterns with only one or two very diffuse rings and it does not in any way interfere with the crystalline patterns of cellulose. So they are not chemically combined. Lignin has been separated with 2% alc. *aq.* NaOH in the cold by Phillips and others. An etherl inkage would hardly be ruptured under these conditions. Ordinary hydrolysing agents fail to separate lignin from cellulose. The linkage is therefore not of an ester type as well.

A somewhat allied question has been raised by some workers—as to whether carbohydrates are constituent part of lignin. Hägglund first obtained a pentose (an arabinose) by boiling HCl-lignin with 3% HCl. Others reported to have found furfural by distilling lignin with 12% HCl. This lent support to Hägglund. Schmidt has defined lignin as a compound of an aromatic body with not only pentosans but also hexosans. But if the lignin is carefully freed form sugars during preparation, by repeated washings with water, the product no longer gives furfural on distillation with 12% HCl. By boiling the lignin with moderately strong H_2SO_4 under reflux no (hexose) sugar could be detected. The degradation products of lignin have been studied by a large number of workers but except Rassow and Linde who obtained galactose by the oxidation of bamboo lignin with HNO_3, none could find any pentose or hexose. We repeated Rassow's experiments, here with jute lignin but failed to confirm the result. The ultraviolet absorption spectra of lignin and its derivatives by Herzog and Hillmer indicate that lignin is composed of benzene rings with side chain of 3 carbon atoms, which is saturated. It is therefore in disagreement with Schmidt's views regarding the composition of lignin.

Groups

Let us now consider the constituent groups in lignin. The presence of OCH_3 groups has been definitely established in all samples of lignin prepared by different methods and from various sources. It has also been shown that these OCH_3 groups are linked in the form of ether and not as ester, further, no other alkoxyl groups, besides OCH_3, are present in lignin. According to Freudenberg, the OCH_3 groups in lignin are all attached to the aromatic nuclei. He studied the rate of removal of the OCH_3 groups in lignin with HI and found that this corresponded approximately to that of vanillin. It has been found in our laboratory that CH_3I was first formed from jute lignin (during estimation of OCH_3 by the Zeisel's method) at 92°—93° at which vanillin or vanillic acid as well gave CH_3I. With cellulose ether, the temperature is much lower. Even with methylated lignin it is only 83°-84° This observation suggests the presence of vanillin residue in lignin for which, as we shall presently see, there are other valid reasons.

The p. c. of OCH_3 varies rather widely in different lignins—from 12.10 (corn cobs) to 21.00% (sugar mapple) as also with the methods of isolation. These are disquieting facts which have not been explained as yet.

There seems to be little controversy regarding the occurrence of OH groups in lignin—all lignins can be acetylated and methylated. Powell and Whitaker found that their lignin from flax shoves was insoluble in cold NaOH after acetylation, thus indicating the phenolic nature of the OH groups. The behaviour of some organic compounds with one or more phenolic OH groups, towards ClO_2 has been utilised by Schmidt and co-workers as well as by Fuchs and Honsig as an argument for assuming the presence of free phenolic groups in lignin which behaves towards ClO_2 in a similar manner. We have tried here the action of ClO_2 on a large number of orgainc compounds and found that phenols are readily acted upon no doubt but when these phenolic OH groups are protected by acetylation or methylation, the resulting compounds are still decomposed by ClO_2 though less readily. As lignin contains more than one OCH_3 groups attached to the benzene ring, it is obvious that the fact that lignin is acted upon by ClO_2 does not in any way prove the existence of any free phenolic OH in the molecule.

Diazomethane methylates approximately one (0·9) OH group in lignin with a molecular weight of 820. Freudenberg at one time concluded from this fact that lignin contains at least one free phenolic group, Fuchs and Horn strongly supported him. But it was subsequently found that diazo methane reacts though sluggishly, with alcoholic OH groups as well, particularly in high molecular subtances like starch and cellulose; so Freudeberg has discarded his fromer views and is now of opinion that no free phenolic group exists in lignin. Insolubility of lignin in caustic alkalis supports this view.

As we shall see later on, free phenolic groups may appear in lignin during careless isolation of the same by acid hydrolysis, due to the partail splitting off of the $O\text{-}CH_2\text{-}O$ group present in lignin.

The number of OH groups in lignin widely varies with sources and mode of preparation, the acetylation and methylation values even are seldom concordant. We shall try to explain this fallacy later on.

Opinion seems to be divided however regarding the presence of $OOCH_3$ (acetyl) groups. The fact that wood and other lignified materials when, distilled with dilute mineral acids, give acetic acid has caused several investigators to assume that lignin contains acetyl groups. But no lignin preparation uptil now has been found to yield acetic acid under similar conditions. According to Jonas acetyl group is split off from lignin by very strong HCl during isolation even in the cold. We have estimated acetic acid in purified raw jute and in jute delignified by ClO_2. It has been found that delignified jute contains all the acetyl groups present in raw jute. This fact shows that lignin native in jute contains no acetyl groups. More recently, Ritter and Kurth have been able to separate lignin leaving all the acetic acid of the original wood in the carbohydrate portion of the wood. They therefore support our views directly.

Workers on lignin are not unanimous regarding the presence of COOH group in it. Rassow and Wagner measured the conductivity of Na-lignin from pine wood and found it to be a tribasic acid. Mehta determined the acid value of her lignin as 477 and prepared Ba and Ca salts. Waksman explains the relationship between lignin and humus by assuming a COOH group in lignin.

We observed that jute lignin gave CO_2 when boiled with 12% HCl but no furfural. The latter shows the absence of uronic acids or pectin residue in lignin. The p.c. of CO_2 obtained is very small, (1·56%) but it is not due to any extraneous matter associated with lignin. This suggests the presence of a COOH group in lignin possibly with a negative group in the α-position, for it is well known that such acids give CO_2 when boiled alone or with dilute mineral acids. The liberation of CO_2 from these acids is scarcely quantitative. This explains the small amount of CO_2 obtained from lignin. The COOH group could not be esterified.

Like the acetyl or COOH, CHO group has been reported to be present by many investigators but surprisingly enough, evidence is not unequivocal on the presence of such a reactive group. Lignin from various sources without exception have been found to reduce Fehling's solution. Friese considers it to be due to the presence of traces of sugars. According to Powell and Whittaker an active CHO group is present in lignin. But with lignin from jute we have found in our laboratory that no CHO group is present in lignin, the reducing action is due to the presence of two OH groups in the o-position set free during isolation owing to the partial loss of the OCH_2O group. Methylated or acetylated lignin has no reducing property. If the reducing lignin is washed exhaustively with dilute NaOH, the filtrate reduces Fehling's solution but not the residue. If the reducing lignin is methylenated with CH_2I_2 and KOH, the reducing action disappears. Our views explain all these facts satisfactorily. Ordinary reducing lignin does not part with its reducing property even after removal of the last trace of adhering sugars.

The controversy regarding the presence of the $O\text{-}CH_2\text{-}O$ group in lignin is a recent one. Freudenberg obtained HCHO from lignin by distillation with 13% HCl and attributed it to the presence of a $O\text{-}CH_2\text{-}O$ group. Fuchs and Horn, Phillips and Goss obtained HCHO from other lignins in small amounts but regarded the presence of the OCH_2O in lignin with some uncertainty. We have got HCHO in 5 different lignins in appreciable amounts, also in chlorolignin prepared therefrom. Delignified jute gives no HCHO. After removing all the HCHO from jute lignin, we re-introduced the OCH_2O with CH_2I_2 and KOH. The product gave practically the same amount of HCHO again. This proves beyond doubt the presence of the $O\text{-}CH_2\text{-}O$ group in lignin. We have also prepared the acetone compound of lignin, in presence of P_2O_5 at 8° to 10°C. The reducing action (like that of catechol) disappears in both cases. The colour becomes dark when HCHO is split off but again becomes light after the $O - CH_2 - O$ is introduced. The $- OCH_2 - O$ group is very unstable towards acids. So during separation of lignin from lignocelluloses by acid hydrolysis, much of it is lost if proper precautions are not taken.

Unsaturation

The presence of double bond in lignin is still a matter of dispute. To explain the formation of rather stable lignosulphonic acids Klason assumes an ethylenic linkage in lignin. Hibbert and Sankey from the results of bromination concluded that lignin contains an unsaturated side-chain. In their recent formula for liguin Kürschner and Schramek made provision for an ethylene linkage to show its analogy to coniferin and account for the formation of acetic acid on hydrolysis and oxidation. Mehta determined the I.V. of her lignin as 139. But from the absorption spectra, Herzog and Hillmer conclude that the side chain in lignin is saturated.

We have estimated simultaneously the HCl evolved and the Cl entering the lignin molecule on chlorination in Carbon tetra chloride medium. The ratio was found to be 1 : 1 within exprimental errors. This therefore proves that the side chain in jute lignin is saturated. Secondly, in presence of Pd jute-lignin absorbed no H_2. Thirdly, we tried to determine the I.V. of jute-lignin with ICl and IBr. There was slight absorption of these reagents but this does not indicate a double bond as saturated compounds, like phenol, ainsol (but not benzene or benzoic acid) as well, behaved like lignin.

Potash Fusion

Fusion of lignin with alkalies has been done by many investigators—the reaction products in nearly all cases are protocatechuic acid, pyrocatechol, oxalic and other simple aliphatic acids. Melander obtained vanillic acid. Fusion of lignosulphonic acid gave similar result. No new product could be obtained by fusing methylated lignin. These aromatic bodies obtained from lignin and its derivatives by a process which can hardly be characterized as synthetic, unmistakably show the presence of benzene nucleus in the lignin molecule. We fused delignified jute with KOH but failed to detect any aromatic substance in the decomposition products. The p.c. of these aromatic compounds is however not high—it is far below the theoretical. Potash fusion is a very drastic process—with high temperature and longer time we get only CO_2 and oxalic acid. Heuser and Winsvold fused lignin with potash in iron crucible instead of Ni, (Fe being found a catalyst for increasing aromatic products) and in H_2 atmosphere. The yield of catechol was 26% — a figure which could not be reached by any other. The highest yield of oxalic acid was 20%, but much of it owes its origin to the pyrocatechol formed, the yield of which correspondingly diminished. Honing and Fuchs subjected barium lignosulphonate to potash fusion and obtained 10% of proto catechuic acid. Freudenbrg and co-workers however failed to get more than 4·8% protocatechuic acid by fusing pine wood lignin with potash. Blank experiment with protocatechic acid in potash fusion resulted in the disappearance of half of it. So they think that the maximum that could theoreticaly be obtained from lignin is 9—10% only. They criticized Heuser's results.

Butyric acid has been identified as a product of fusion of jute lignin—the highest yield being 9.13%. The formation of this acid indicates the presence of a side-chain of at least 4 carbon atoms in the lignin molecule. Rassow has also obtained butyric acid from bamboo lignin by potash fusion.

Nitration

Lignin is nitrated very readily. Nitration of lignin from different sources has been carried out under different conditions by various workers but no definite compound except oxalic acid has yet been identified. No doubt N_2 enters the lignin molecule —partly as nitrate and partly as nitro group, but the composition of the so-called nitro-lignin has always been found to be variable—the p.c. of nitrogen varies between 5-8·68%. The OCH_3 groups always suffer a loss some times to the extent of 50%. The nitro compound reduces Fehling's solution very readily—boiling with strong alkali did not give NH_3. The nitro group could not be reduced apparently and diazotization was unsuccessful. It has been explained by the fact that all nitro groups cannot be reduced *e. g.* nitro salicylic acid. Kürschner claims to have isolated a crystalline nitrated product from lignin using dilute alcoholic solution of nitric acid. But this requires confirmation. Hibbert in a recent paper describes to have obtained a diazotised compound from nitro lignin—he has prepared a brown dye for silk and wool by coupling the diazo compound with β-napthol disulphonic acid. This too requires corroboration from other workers. No better result has yet been possible to obtain by nitrating lignosulphonic acid.

The simple aliphatic acids like oxalic and acetic throw but little light on the constitution of lignin. The highest yield of oxalic acid is found to be different in different cases—from jute lignin we have obtained 38·1% of oxalic acid. But even a higher amount does not support a sugar structure for lignin in view of the fact that we have found oxalic acid among the oxidation products of catechol and proto catechuic acid (with HNO_3) which are degradation products of lignin. Moreover, catalysts like V_2O_5 and ammonium vanadate diminish the yield of oxalic acid.

Horn appears to be the only man who has obtained mellitic acid by oxidising lignin with nitric acid. This if confirmed, will lend a strong support to Schrauth's formula for lignin in which the central benzene ring is connected with 6 carbon groupings. We repeated the experiment of Horn with jute lignin but no trace of mellitic acid could be detected. Rassow obtained galactose from the oxidation of bamboo lignin with nitric acid. But none other could confirm this result. We to failed to do the same here with jute lignin.

The readiness with which lignin is nitrated—many workers believe—indicates that it has a phenolic, or, at any rate, an aromatic character.

(To be continued)

Scientific Research in Industry

Change in Outlook of British Industry Towards Research

THE Advisory Council of the Department of Scientific and Industrial Research, of which Lord Rutherford is the Chairman, directs attention in the Department's Annual Report recently issued to important developments in the outlook of industry in this country. The last five years have witnessed, the report states,

> "the fruition of the policy adopted by several large industrial undertakings of setting well balanced teams of research workers, including chemists, physicists, engineers and where necessary biologists, to solve a particular problem or to develop a new product. This method of attack has led to the steady improvement of the efficiency of electric lamps, to the position this country has won in high-definition television, to the development on a commercial scale of the huge plant for the conversion of coal into oil by hydrogenation, to the growth of the plastics industry and to many other important advances. This country has never been lacking in men of genius whose inventive capacity can give birth to the ideas which bring about industrial advances. What is new, in this country, in present times is the way in which industry has taken up these new ideas and brought them to the stage of industrial application by team work in which the scientists, the technical men and in fact all the departments into which a great business is organized have worked side by side in the practical attainment of an objective."

The future, the report continues, no longer lies with industries content to make sporadic advances at the call of the brilliant individualist. Co-operation, team work, and an extensive organization on the technical side are essential for success.

Progress of the Research Associations

For this reason the Department attaches great importance to the development of the Co-operative Research Associations formed under the scheme launched in the early days of its existence. The steady increase in the sum which industry is providing each year for their development gives, the report states, a good reason "for taking an optimistic view" of their future. In the last three years this sum has increased by 40% from £167,370 to £232,468. In the same period, the grants from the Department for these organizations have increased from £68,212 to £107,451. The year has also afforded other practical evidence of a forward movement in industry regarding research.

New laboratories at Perivale, costing over £29,000, erected by the Electrical Research Association, were opened by the Duke of Kent. The Research Committee of the Institution of Automobile Engineers—the co-operative research organization of the motor industry—has acquired and equipped new laboratories at a cost of £20,000 on the Great West Road. A further 20,000 feet has been added to the laboratory accommodation of the Paint Research Association. The greatest increase has, however, been at the Shirley Institute, the headquarters of the Cotton Research Association where Lord Derby opened extensions to the laboratories which had cost £41,000. The area covered by the buildings, accommodating the work of this, the largest of the research associations, now extends over three acres, and the total cost of the laboratories and equipment has exceeded £200,000. In 1920 the cost of the research carried out at the Shirley Institute was £19,000 and the staff numbered 25. Last year its income was £84,000, and the staff employed numbered 270.

In spite of such advances, the report, however, still regards the position of the Research Association movement as a whole as not yet entirely satisfactory. The Department is prepared to provide a further £66,000 each year to the support of the Research Associations, and would have been prepared to find that sum in each of the past two years had industry been ready to provide an equivalent contribution. In fact, the income of the associations might have been increased by a further £150,000 a year, of which only half had to be found by industry, if full advantage had been taken of the Department's offers which have been made to and accepted by various Research Associations.

Contact with Industry

"From the point of view of industry," the report continues, "research is only a means to an end. The end is the applications of scientific knowledge to all stages of production and the development of new processes." To achieve this, close contact with industry is essential, and the Advisory Council gives a number of examples from the recent work of the Department of the various methods adopted to secure close contact with and co-operation by industry.

The Fire Offices Committee of the London insurance companies, in co-operation with the Building Research Station, has erected a new Fire Testing Station at Elstree which will be used for the study of the fire resistance of full scale parts of buildings. The results should be of great value in giving greater confidence in the use of new materials for building construction by removing any fear that the introduction of novel forms of construction may be introducing unknown fire risks.

The Institution of Heating and Ventilating Engineers has also provided a new laboratory at the Building Research Station for research on the warming of buildings. It consists of one room built within another and so arranged that any kind of weather conditions can be maintained in the space between the two. The result is that research on heating systems used in the inner room can be continued independently of the vagaries of our climate.

A "Consultative Group" which brings the shipping industry in close contact with the Department's work on the transport and storage of food has played an important part in the rapid development of the new trade in chilled beef with Australia and New Zealand, and in the application of improvements for transporting Empire fruit and dairy produce. The Dominions Tonnage Committees of Australia and New Zealand and the Union Castle Mail Steamship Company are making substantial contributions to the Department for the development of the work in this field.

Savings in the Milk Industry

Another striking example is the work the Department is carrying out with the co-operation of the Milk Marketing Board on the purification of waste waters and effluents from milk depots, creameries and condensed milk factories. Two different methods have been worked out and shown to be successful on a large scale, by which the polluting character of milk washings can be reduced by 99% and 97% respectively. Investigations have also drawn attention to the losses of milk, cream, whey, etc., carried away in the waste waters. It has been shown that the wastes from this cause can be reduced by nearly three million gallons per year. At the low wholesale price of 5d. a gallon for milk for manufacturing purposes, this means, the report points out, a saving of about £50,000 a year to the industry. Five per cent of the total quantities of by-products, whey, skimmed milk, etc., is frequently lost at present in the waste waters. This loss can be reduced to about 2%. The suggestions put forward for reducing these wastes have already been adopted at several factories.

The summary included in the report of the work carried out in the laboratories of the Department and of the Research Association during the year again reveals the infinite variety of the subjects covered by the Department's activities.

A Radio Discovery

One of the most interesting results of the year has been in connection with radio research. Three new electrified regions in the atmosphere have been discovered between 4 and 40 miles above the earth. These regions are thus well below the wellknown Heaviside and Appleton regions which play such an important part in carrying broadcasting to long distances and in making Empire communications on short waves possible. The new layers are likely to be important in connection with the travel of very short waves which are able to pass without reflection through the upper layers. Isolated trials on high frequencies including those in use for television have not yet indicated any frequency so high that its return from the middle atmosphere can be regarded as unusual. It is believed that local thunderstorms are a probable source for replenishing the electricity in the newly discovered layers.

The Transport and Storage of Food

At the Low Temperature Station, Cambridge, the effects of radiation from radioactive substances in destroying bacteria are being studied in connection with the storage of meat.

Methods of storing eggs in different concentrations of carbon dioxide are being tried out on a large scale. A high concentration of, say, 60% prevents attack by mould and gives an excellent yolk but a very fluid white.

The manner in which the quality of pork and bacon is linked with the growth and diet of the pig is being studied. In the later growth of a pig, changes take place in the chemical composition of the muscular tissues. These start near the head and travel to the tail. This head-to-tail wave of growth explains why alterations in the rate of growth affect certain parts of the body more than others and influence the form and quality of the carcass. An ounce of cod-liver oil a day may be good for the living pigs but causes the fat to become rancid in curing. Heavy exercise before slaughter, such as rapid walking for a quarter of a mile, makes the pigs' tissues more alkaline than they would have been had the pigs been rested for a day or two. This fact has been found to be of importance in dry salt curing.

Experiments have been made on the "gas storage" of pears. British Conference pears have been stored in refrigerated chambers with the atmosphere adjusted to contain the correct amount of carbon dioxide for long periods, extending well into the summer. When removed from the store the flavour, texture and appearance of the pears were entirely satisfactory.

Results are given of experiments on the gas storage of Williams' Bon Chretien pears. Normally this variety is very difficult to market because it ripens quickly at ordinary temperatures and remains in an eating-ripe condition for only a few hours. By gas storage, in an atmosphere containing 2.5% oxygen and 5% carbon dioxide at 34°F., the fruit was held in a marketable condition until the middle of March. On removal from the store at this date, the report states that the pears ripened to a good quality in just over a week and remained in an eating-ripe condition for two or three days. The correct conditions for gas storage have been maintained on a commercial scale in a 30 ton experimental gas store.

Excellent results under commercial conditions have been obtained by improved methods for the preservation of peas by freezing. Quick cooling and freezing following blanching in hot water are essential and the colour and flavour are improved by the addition of just the right amount (0.1 – 0.15%) of sodium carbonate.

The Storage of Flour

The storage of flour is being studied by the Flour Millers Research Association. So far it has been found that three factors come into play. First, there is some effect, not yet fully understood, produced by the growth of fungi during storage, which improves the baking qualities of the flour. Secondly, there is a factor causing deterioration in its quality owing to the fats in the flour becoming converted into glycerine and fatty acids, and finally there is an indirect beneficial factor resulting from the fungi consuming the fatty acids. It has been found that during storage the bacteria content of the flour diminishes to a small value while the fungi content rises to very high values.

Stale Bread

Another investigation being carried out by the Flour Millers Research Association deals with the staling, flavour and keeping quality of bread. What the housewife usually calls "staling" is due as a rule to poor keeping qualities in the bread. Exhaustive investigations of this aspect of the problem have shown, the report states, that bread made in the best possible way from the best possible flour will leave little to be desired in the matter of keeping quality. Such bread will retain its edibility for ten or twelve days whereas bread improperly made from poor flour may become most unappetizing and almost uneatable in two or three days. Many other factors contributing to keeping quality have been investigated. The results of this work suggest strongly that if more attention were paid to commercially controllable factors promoting good keeping quality of bread the serious problem of stale bread would lose some at least of its importance.

The report points out, however, that this important commercial aspect of bread staling is not true staling. This, it is stated, is caused by a change in the form of the starch in the bread from its natural form, occurring at high temperatures, to its natural form at low temperatures. Keeping quality is independent of this in true staling except that if true staling could be prevented the bread would probably always keep well. Retaining bread at a relative high temperature, it is stated, is a sure way of preventing true staling but this is not easy to carry out in commercial practice on account of increased mould growth at high temperatures.

Better Fitting Boots and Shoes

The most outstanding development in the work of the Boot and Shoe Research Association has been the start of what may be called "walking research". Everyone has probably suffered from shoes which seemed to fit all right in the shop but after being worn some time have developed creases and folds which pressed on the foot and caused the growth of corns and other discomfort. In order to present manufacturers with the means for designing better fitting shoes the Research Association is making very careful records of the way in which various people walk. To do this a moving platform or treadmill is used on which a person can walk without moving away from a particular point. While walking thus a cinematograph record is made of the movements of the foot which is afterwards carefully analysed. Records are also being made, by electrical thermometers, of the skin temperature of the feet when wearing different types of shoes. The gaits of various individuals and the effect of different kinds of shoes upon them are also being investigated and records are being obtained which show the period of contact with the ground of various parts of the foot. The results suggest that some shoes are much more likely to interfere with the normal gait than others and this is throwing light upon what is correct in shoe design and construction.

Health

Many of the activities of the Department have a more or less direct connection with public health. Besides the investigation on the problems of sound-proof buildings, tests have been carried out at the National Physical Laboratory in connection with the reduction of noise from aircraft engines, large electrical transformers, road drills and traffic.

An investigation has also been begun on the production of static electrification in operating theatres of hospitals. Some of the anaesthetics in common use are of an explosive character, and the possibility of the production of electrostatic charges and the risk of their ignition by sparking is one which cannot be neglected.

At the request of the Home Office a preliminary examination has been undertaken of the risk of ignition by sparks due to static electrification in dry cleaning works. Some of the liquids used in dry cleaning produce an ignitable vapour when mixed with air, and explosion may result if the conditions of operation allow the generation of appreciable electrostatic charges.

Methods for detecting in the atmosphere small quantities of poisonous gases commonly occurring in certain industrial processes have been worked out.

Researches of the Dental Board on dental-amalgams have been completed during the year. The results have shown, the report states, that the composition of the alloy used in making the amalgam must lie within very narrow limits if the dentist is to produce fillings which will continue to fill cavities without contraction. The precautions which must be observed by the dentist in preparing the amalgam have also been established. The conditions both of manufacture and use of materials for amalgam fillings have been determined as the result of an extended series of experiments, in which the changes of volume at mouth temperatures have been measured, sometimes over long periods. The results of this work should place this country ahead of the rest of the world in this particular aspect of dentistry.

Interesting physical work has been carried out in connection with radium treatment of diseases. The strength of the radiations from a specially designed radium unit, with which various radium "skin distances" can be obtained, has been measured in a water "phantom", a celluloid vessel containing water and giving the same scattering and absorption effects as a human body. Means have been developed for accurately measuring and controlling tissue-dosage. Another investigation is in progress in connection with the weak radiations which may reach distant parts of a patient's body during treatment. These radiations, it is believed, may be of importance in "constitutional effects" of radium treatment, *e. g.*, blood changes and general health. The method used is to measure the electricity produced (ionization) in air gaps in a laminated celluloid model of the body.

The improved apparatus for investigating artificial radioactivity is being used in a search for new radio elements of very short life whose existence is suspected. Particular attention is being given to those elements which occur in the human body.

Textile

The new buildings of the Cotton Research Association include two large weaving sheds for experiments on cotton and rayon respectively. A plant for controlling the humidity of the air has been included in both sections. The Cotton section has a simple plant by which humidities between 65 and 75% at 70°F can be maintained throughout the year. The effect of humidity on the weaving of rayon is not so well known and is to be studied in the new shed where the cooling plant installed allows humidities as low as 50% to be maintained.

Intensive research is in progress on the chemical action of light on dyed cotton fabric. Some dyes apparently cause the fabrics to disintegrate, while others seem to protect them. The report states that

> "The growing belief of the cotton industry in scientific research and in the capacity of the Shirley Institute to apply research results to industrial processes is resulting in still heavier demands on the Association, so that it seems not unlikely that further increases in resources, space and personnel may have to be contemplated at no very distant date."

One of the events of the year has been the inauguration of a section for silk research at the Shirley Institution as a result of the decision to transfer the work of the old British Silk Research Associations to Didsbury. Rapid progress has already been made on some of the more pressing problems of the silk industry, in particular, on the development of rapid methods for mechanically testing silk fineness.

Extensive trials of the process for producing unshrinkable wool developed by the Wool Research Association are proceeding under semi-manufacturing conditions in a specially erected plant. This plant is being used for the instruction of the operatives of firms working the process, plans for the commercial release of which are now being considered.

Consideration has been given during the year to the need of some more satisfactory means than the present voluntary levy for raising funds for extensions in the work of the Wool Research Association, the necessity for which is generally recognized. The desirability of a broader basis of organization is emphasized by the movement now under way in the wool producing countries of the Empire, towards research on the better production of wool. Co-operation between manufacturers and producers is essential, the report states, if the future of wool is to be assured by all the resources derivable from science. An example of work now in hand, which is of importance to both sheep-breeders and manufacturers, is the investigation of methods for the quantitative measurement of wool quality.

SCIENTIFIC RESEARCH IN INDUSTRY

Good progress has been made in the various researches of the Linen Industries Research Association which aim at the development of mechanical methods for processing flax. The Association's experimental flax factory in Norfolk was completed during the year. At this factory, crops, grown on about 260 acres of the Royal Estates, Sandringham, were treated. The 1935 crop which was processed last year was better than the 1934 crop, and the 1936 crop promises to be much better than either. Unfortunately, however, bad weather made harvesting difficult and about 40 acres had to be pulled by hand instead of by the new mechanical methods. About 700 tons of material were dealt with satisfactorily in the new de-seeding plant. A flax-tying machine and a sewing machine of new design were introduced during the year. Work is in progress at the newly completed substation of the Association in Norfolk on the manuring of flax and the control of weeds. A new form of flax breaker for unretted as well as retted flax is giving promising results at the Association's laboratories at Lambeg (Northern Ireland). Bulk quantities of unretted flax have been prepared and spun and 20 acres of flax have been grown in Scotland to provide material for large scale trials by Scottish spinners. If it can be demonstrated that a good market exists for unretted fibre the objections, which retting by steeping the fibre in water on the farms presents to many potential growers, will be overcome and the development of larger supplies of home-grown and Empire flax will be encouraged.

Iron and Steel

The annual expenditure of the Iron and Steel Research Council of the British Iron and Steel Federation—the co-operative research organization of the industry—has increased from £15,624 in 1933 to about £50,000 last year. The research expenditure of individual companies has also considerably increased in the last 12 months. About 35% of the Council's expenditure is on long range research not capable of immediate application, but of the first importance to the future progress of the industry. The results of other researches have increased productive efficiency, improved quality and are progressively supplying the need for steel capable of standing up to the high temperatures now employed in modern industry.

The Council has collected and examined data regarding existing practice in the industry. This has provided a standard by which the effect of changes can be measured, and has led to rapid improvements in efficiency both in smelting and steel making. This has applied not only to the less efficient plants, but also to those known to be highly efficient. The Council's work has led to a great increase in the degree of control by scientific instruments in steel making, and robust apparatus of high precision for such work is now being made by British firms at prices competitive with foreign apparatus.

During the year special attention has been devoted to rolling mill practice. The work carried out in co-operation with the Building Research Station has shown that blast furnace "foamed slag is a satisfactory material for making light-weight concretes. This opens up other possibilities in the use of slags previously regarded as waste products. Other work has led to an increase in the life of ingot moulds with a consequent lowering of steel costs. In view of the growing scarcity in our natural resources of first rate coking coals for metallurgical work, and actual deterioration in coke quality in some districts, fundamental research is now in progress on the constituents of coal and its methods of treatment to give high quality coke.

In co-operation with the co-operative research organization of the automobile industry, a comprehensive research on steel sheet has been undertaken. The automobile industry is by far the biggest consumer of steel sheet, and there are various problems connected with its manipulation and testing which have resulted in considerable wastage and difficulties.

Aircraft

Many new designs of aircraft have been tested in the wind tunnels of the National Physical Laboratory, and two additional tunnels of special type are in course of erection. Remarkable results have been obtained in a study of the effect of even slight surface roughness of the wings, etc., on the speed and maximum lift of aircraft. For the moderate size machine, flying at about 150 miles per hour, the roughness due to particles having a size of 1/100th of an inch effects the drag. Problems of stability and control have been further studied especially in connection with the low wing monoplane. Two methods have been devised for balancing the brake flaps which are being increasingly used as a control in landing.

In the search for ever lighter materials for aircraft construction, new light alloys of magnesium—a metal 1/3rd lighter than aluminium—have been produced and found suitable for stressed parts up to 150°C, and possibly 250. The Chemical Research Laboratory has found that corrosion of magnesium alloys used for fuel tank construction by leaded aircraft fuels can be prevented by certain organic substances, notably quinoline. Radio aids to the navigation of civil aircraft are being studied by the National Physical Laboratory for the Air Ministry.

Some other Points from the Report

The number of ship designs tested by means of models in the tanks of the William Froude Laboratory numbered 73, and again exceeded the number tested in any previous year. An investigation of the effect of hull shape on the performance of high speed vessels of the cross-channel and liner type in smooth and rough water has been completed.

A type of pulverized fuel burner and distributor developed at the Fuel Research Station has enabled twice to three times as much steam to be obtained from a Lancashire boiler as it was normally rated to give.

The Geological Survey has found that the steady fall in the water level in the chalk below London has recently been replaced by a rapid acceleration due to a heavy over-pumping removing more water than can gain access to the deep-seated reservoirs.

The possibilities of home-grown timber for street paving and the wood pulping industry is being investigated.

At the Chemical Research Laboratory an improved electrical insulating material has been obtained by the blending of rubber derivatives with synthetic resins from tar. The corrosion of locomotive boiler tubes has also been investigated there by laboratory methods and in a model boiler.

The life of the silica brick linings of gas retorts is now 25% longer than ten years ago, mainly owing to the work of the Refractories Research Association, and the economics resulting to the gas industry therefrom are very great indeed. The Electrical Research Association has produced a new type of fuse for radio receivers or electrical clocks. It has also laid down conditions for earthing overhead lines carried on poles, or towers, which will protect cattle grazing under them from shock in the case of faults developing on the lines.

The Paint Research Association are investigating the problem of painting in winter and wet weather, and studying how the difficulties can be overcome by some simple modification in the composition of the paint. The Association has devised apparatus by which paint can be applied and tested under any weather conditions between tropical and arctic.

As a result of co-operative research, cylinder wear in automobiles is no longer considered by many manufacturers to be the serious problem it was a few years ago.

The Rubber Research Association is working on the development of durable rubber for gas masks, and is devising tests which should ensure supplies of reliable articles to be available should necessity arise. Among other subjects the Association is studying the resistance of rubber and the improvement of rubber for shoe soles and heels.*

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* Summary of the report of the Department of Scientific and Industrial Research for the year 1935-36.

Progress of Chemistry in Ancient India

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[The following article has been taken from the November issue of *The Register* of Phi Lambda Upsilon. So little about the scientific achievements of the ancient Hindus is known in the West and especially in America that the editors of *The Register* did well in inviting the eminent Indian chemist, Sir P. C. Ray, to write for them this interesting history of the chemical knowledge of the ancient Hindus. We reproduce it in part for the benefit of our readers and acknowledge our thanks to *The Register*.—Editor, *Sc. & Cul.*]

It is generally taken for granted that the Hindus have always been a dreamy, metaphysical people, prone to meditation and contemplation. No wonder that the poet should exclaim:

"The East bowed low before the blast
In patient, deep disdain,
She let the legions thunder past
And plunged in thought again."

In ancient India, however, physical science found her votaries. India was once the cradle of mathematical sciences including arithmetic and algebra; the system of notation, popularly ascribed to the Arabs, is really the product of the Hindu brain.

Max Müller says somewhere that if India had presented no other gift to Europe than that of the numerals, the debt of the latter to the former would have been unrequitable.[1]

I shall, however, confine myself to the keen powers of observation and the necessity of experimental methods enjoined by the Hindus of old, so far as chemical processes are concerned. Indeed, Dhundukantha, the author of the standard iatro-chemical treatise, *Rasendra Chintamani* (gems of mineral preparations), says:

> "They are alone to be regarded as real teachers who can show by experiment what they teach. They are the deserving pupils, who, having learnt the experiments from their teachers can actually perform them. The rest, both the teachers and the pupils, are merely stage actors."

This author, again, acknowledges his indebtedness to the standard work on the subject, *Rasarnava*, in which occurs an elaborate account of the processes of sublimation, distillation, and similar operations as well as the apparatus required for the processes. Indian alchemists are also eloquent in their veneration for and indebtedness to the great adept, Nagarjuna, to whom is ascribed the invention of the above processes. One instance will suffice to give you an idea of the methods adopted for the purification of mercury. The Sanskrit text, literally rendered, runs as follows:

> "Fraudulent dealers adulterate (alloy) mercury with lead and tin, hence these impurities are to be removed by subjecting the mercury to triple distillation."

The identification of metals by the coloration of their flames is referred to in *Rasarnava* (circa 1200 A. D.):

> "Copper yields a blue flame, that of tin is pigeon-coloured, that of lead is pale tinted........"

We are not aware of similar tests being applied anywhere at such an early date.

The ancient Hindus knew the distinction between potassium carbonate and sodium carbonate; the former is called *yavakshara* (ash from the spikes of barley) and the latter *Sarjikakshara* (equivalent to natron from Egypt).

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[1] The learned professor of Sanskrit of Oxford University says: "In science, too, the debt of Europe to India has been considerable. There is, in the first place, the great fact that the Indians invented the numerical figures, used all over the world. The influence which decimal system of reckoning dependent on those figures has had not only on mathematics, but on the progress of civilization in general, can hardly be overestimated. During the 8th and 9th centuries Indians became the teachers in arithmetic and algebra of the Arabs and through them of the nations of the West. Thus, though we call the later science by an Arabic name, it is a gift we owe to India."—Macdonnell's *History of Sanskrit Literature*. p. 424.

The earliest record of this is to be found in the old Hindu work, *Susruta*. The *Charaka* and the *Susruta* are the two standard and authoritative treatises on *Ayurveda* (science of life). The *Charaka* is more concerned with medicine, while the *Susruta* relates more or less to surgery. In the *Susruta* the two modifications of alkali are referred to as *tikshnakshara* (*tikshna, i.e.*, sharp or caustic; *kshara, i.e.*, alkali) and *mridu-kshara, i.e.*, mild alkali. The distinction is quite clear. In the *Susruta* we have many land plants mentioned which have, of late, been botanically classified.

The *Susruta* says: "On an auspicious day cut the plants down, burn them, and boil the ashes with water in an iron pan and then filter through cloth folded several times." The clean solution that is obtained is rich in potassium carbonate and is termed mild alkali.

Next comes the description of the preparation of caustic alkali, and this is the most scientific portion. "Collect several kinds of limestone and shells and 'burn' them strongly and add water to the resulting product. Next mix this slaked lime with the lixiviated liquid obtained above and boil and stir with an iron ladle."

Here we span two thousand years from the *Susruta* to the remarkable discoveries of Joseph Black, who was an M. D. of Edinburgh. In his doctorate thesis (presented in 1755) he gave, for the first time in Europe, the scientific explanation of the difference between caustic and mild alkalis.

This method you will look for in vain in any European treatise before the 16th or the 17th century. The process as given in the *Susruta* is so scientific that it can be bodily transferred to any modern textbook on chemistry. Besides recommending the use of an iron vessel for boiling the liquid, the book further says that the *kshara*, so obtained, must be stored in an iron vessel with its mouth closed. Even to-day we keep caustic potash either in iron or silver vessels. The points to be noted here are that the *Susruta* gives not only a very accurate method of preparation and presentation of the two kinds of alkali but also the distinction between the two varieties—*tikshna-kshara* and *mridu-kshara*—is clearly recognized.

Davy isolated potassium and he says, "The ancients did not know how to distinguish between potassium carbonate and sodium carbonate." But in our *Ayurveda* this sharp distinction has been very clearly stated.

M. Berthelot, under whose inspiration I took to writing my *History of Hindu Chemistry*, in reviewing my book, says of this portion "that the Hindus possibly got their knowledge of this method from the Portuguese." (*Jour. des Savants*, Jan, 1903, p. 34). But against that I may point out that Chakrapani, who was the court physician of Nayapala (1050 A. D.), king of Gour, in the treatise which goes by his name, quotes this mode of preparation verbatim from *Susruta*. A much older treatise, *Vagbhata*, also does the same. In the course of my studies, I came across a remarkable passage in a Buddhist work which dates as far back as 140 B. C., I refer to the *Milinda Panho*. Professor Rhys Davids translates the portion as follows:

> " And when the inflammation had gone down and the wound had become sweet, suppose he (the surgeon) were then to cut into it with a lancet, and burn it with caustic. And when he had cauterized it suppose he were to prescribe an alkaline wash.... .Now tell me, O King! would it be out of cruelty that the surgeon...... thus cut with the lancet and cauterized with the stick of caustic. [1]

The use of metallic preparations mentioned in the Hindu Pharmacopoeia also dates from a very early period. In Europe Paracelsus was the first to introduce metallic preparations into medicine. But in India, Vrinda, who preceeded Chakrapani by at least a century and therefore must have flourished about the 9th century A.D. or even earlier, was the first to prescribe *Kajjvali* (black sulphide of mercury) as a medicine. Chakrapani gives an elaborate description of the process of making *Kajjvali.* In Europe this preparation was not known before the 17th century.[2]

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[1] *Sacred Books of the East*, vol. xxxv, p 168.

As regards the high degree of skill in metallurgy attained by the Hindus, it is enough to mention the iron pillar near Delhi. Recently Sir Robert Hadfield referred in this connection to an examination conducted at his works on iron from the famous pillar of Delhi, which is reputed to be over 1,000 years old. He said that the analysis and tests to which the material had been subjected showed the iron to be a wonderful piece of work. It certainly had properties which enabled it to resist corrosion to a much greater extent than modern wrought iron. It was a most remarkable fact that in spite of all the scientific advance which had been made in the metallurgical field the pillar of Delhi was, as far as he could judge, a metal of much better quality than anything which could be produced today. He made that statement with a full sense of responsibility. Some of the secrets of metallurgy had died out. Then *again the name of the metal* zinc occurs in European history for the first time in the works of Paracelsus (1493-1541), who leaves us in the dark as to the nature of his Zincken which he designates as semi- or bastard metal.

The extraction of zinc from the ore (calamine) can be followed in every detail from the account left to us in *Rasarnava* and specially in *Rasaratnasamuchchaya.* The process as given in the latter work is reproduced below. The literal rendering of it runs thus:

> "Rub calamine with turmeric, the chebulic myrabolaus, resin, the salts, soot, borax. Fill the inside of the crucible with the above mixture and dry it in the sun. Close its mouth with a perforated saucer. A vessel filled with water is embedded in the ground, over which the above vessel charged with the mixture is inverted, which is again heated by means of a charcoal fire. The operation is stopped when the flame issuing from the mass changes from blue to white. The essence of the metal which drops into the water and has the lustre of tin is to be collected."

Indeed the process so elaborately given above might be quoted almost verbatim in any treatise *on modern chemistry. It is practically the same* as distillation per descensum—the flame of a bluish tint issuing from the mouth of the crucible indicates the combustion of carbon monoxide so often observed in metallurgical operations.

I need not proceed further. I shall conclude this topic with the apposite words of the illustrious French chemist, Jean Baptiste Andre Dumas.

> "What an awakening for Europe! After two thousand years she found herself again in the same position to which she had been raised by the profound intellect of India and the acute gen us of Greece." (The first *Faraday lecture* delivered before the London Chemical Society, June 17, 1869)[1]

Knowledge of Technical Arts and Decline of Scientific Spirit

In ancient India the useful arts and sciences, as distinguished from mere handicraft, were cultivated by the higher classes. In the white *Yajurveda* and in the *Taittiriya Brahman*, we meet with the names of various professions which throw light on the state of that period; unfortunately a knowledge of these perished with the institution of the caste system in its most rigid form. Among the sixty-four *kalas*, or arts and sciences which are enumerated in the old work of Vatsayana called *Kamasutra*, occur, with others, the names of the following:

(1) *Subarnaratna pariksha*—or the examination and valuation of gold and gems.

(2) *Dhatubada*—or chemistry and metallurgy.

(3) The art of extracting alkali (already referred to).

We also find that among the companions of the poet Vana[2] (7th century A.D.) were an assayer and a metallurgist! Such terms as *Lohavid* (adept in iron metallurgy) and *Dhatuvid* (metallurgist and chemist), which occur repeatedly in Sanskrit literature, show that the metallurgists were held in high esteem and expert knowledge sought after.

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[2] "Das Schwarze Schwefelquecksilber lehrte zuerst Turquet de Mayerne, im Anfange des 17 jahrhunderts, durch Zusammenreiben von Warmen Quecksilber mit geschmolzendem schwefel daratellen," Kopp: *Gesch der chem.*, vol. 4, 186.

1. Hoefer in his admirable *Histoire de la chimie* also expresses the same view: "L' Inde est le berceu de la fileation des peuples qui merchant a la tete de la civilization." Vol I. Ed. 1866.

2. Cowell and Thomas' Trans of *Harsha Charita* p. 33.

In the Vedic age the Rishis or priests did not form an exclusive caste of their own but followed different professions according to their convenience or natural tastes. But all this was changed when the Brahmins reasserted their supremacy on the decline or the expulsion of Buddhism.

The caste system was established *de novo* in a more rigid form. The drift of Manu and of the later *Puranas* is in the direction of glorifying the priestly class, which set up most arrogant and outrageous pretensions. According to *Susruta*, the dissection of dead bodies is *sine qua non* to the student of surgery and this high authority lays particular stress on knowledge gained from experiment and observation. But Manu would have none of it. The very touch of a corpse, according to Manu, is enough to bring contamination to the sacred person of a Brahmin. Thus we find that shortly after the time of Vaghata, the handling of a lancet was discouraged and anatomy and surgery fell into disuse and became to all intents and purposes lost sciences to the Hindus.

The arts being thus relegated to the low castes and the professions made hereditary, a certain degree of fineness, delicacy and deftness in manipulation was no doubt secured but this was done at a terrible cost. The intellectual portion of the community being thus withdrawn from active participation in the arts, the how and why of the phenomena (the co-ordination of cause and effect) were lost sight of and the spirit of inquiry gradually died out among a nation prone to speculation and metaphysical subtleties and India for once bade adieu to experimental and inductive sciences Her soil was rendered morally unfit for the birth of a Boyle, a Des Cartes, or a Newton, and her very name was all but expunged from the map of the scientific world.

In this land of intellectual torpor and stagnation the artizan classes, left very much to themselves and guided solely by their mother-wit and sound commonsense which is their only heritage in this world, have kept up the old traditions. In their own way they display marvellous skill in damascening, making ornamental designs on metals, carving on ivory, enamelling, weaving, dyeing, lace making, goldsmith's and jeweller's works, etc.

The above is quoted from my *History of Hindu Chemistry*, first published in 1902. Exactly a third of a century has elapsed since then. At that time I little dreamt that I should live to revise my estimate of the gloomy forebodings. Fortunately, India has roused herself form her age-long slumber. She is no longer to be counted as a Rip Van Winkle. She is now *en courant* with the latest progress in sciences. The discovery of heavy hydrogen by Urey and the actual isolation and identification of artificially radioactive elements by Joliots excite as much interest in the laboratories of India as in those of Europe and America. Already the literature on the Raman Effect is voluminous. I sincerely hope that India will continue to contribute her quota to the progress of science and take her rightful place in the comity of nations.

Experiments on the Photon Theory of Scattering

A great deal of interest has been aroused by recent investigations undertaken to test the validity of the photon theory of scattering. Experiments have been carried out independently by Shankland, Jacobsen, Bothe and Maier-Leibnitz and others. Short notes on some of these have from time to time appeared in this journal; here it is proposed to give a connected account of the whole series of investigations on this subject leading up to the most recent ones. Before proceeding to describe the individual experiments we shall discuss the different consequences of the theory which can be tested experimentally.

It is well known that in Compton's theory, the process of scattering is regarded as an elastic collision between a photon and a free electron resulting in a scattered quantum of lower frequency and a recoil electron. During the collision it is assumed that the laws of conservation of energy and momentum hold good. The relation between the change in the wavelength and the angle of scattering, as deduced from the theory, has been definitely established in numberless experiments using comparatively light substances as scatterer. Moreover, scattering by bound electrons has been insvestigated, where instead of a sharp line a continuous band appears on the longer wave side. Sommerfeld has shown lately that this band has a sharp limit on the high frequency side and has postulated the existence of discrete lines (Raman Spectrum) in between the band and the original line. He is of opinion that the phenomenon observed sometime ago by B. B. Ray of Calcutta is of this nature.

Besides this direct verification of the relation between the change of frequency of the incident photon with the direction of scattering, there are other important consequences which correlate the scattered photon with the recoil electron. Thus, one is that the scattered quantum and the recoil electron must appear at the same instant of time; the second one is that there should be a strict angular relation between their directions of ejection and further, their momenta be coplaner with that of the incident photon. Several experiments have been devised to test these points. These will be dealt with presently; for convenience they will be classified into two groups according as they aim at the correlation in time or in space.

Correlation in Time

The first experiment to test the coincidence in time was carried out by Bothe and Geiger in 1925. The lightest element viz., hydrogen gas, scattered the X-rays. Two point-counters were placed opposite each other and close to the original beam to receive the scattered quanta and the recoil electrons. The scattering took place from a volume of gas and no attempt was made to define the direction of scattering. A thin platinum window prevented the recoil electrons from entering into the photon counter and a magnetic field was applied to deflect the recoil electrons into the electron counter. By simultaneous photographic recording 66 exact coincidences were obtained in 5 hours time, and this was considered to be in support of the photon theory.

The next experiment in this line and with definite results is that of Shankland with hard γ-rays. He has introduced a good deal of elaborations into the technique. Batteries of specially constructed counter-tubes were used for detecting the photons and the recoil electrons. He carried on a series of experiments using air, Be, Al, and paraffin as scatterers. Coincidences were observed with counters placed in the directions predicted by the theory as well as in other directions. In some of the experiments one of the counters was rotated by 90° about the direction of the incident beam. The number of concidences observed in the expected direction was too low and was practically same as in other directions. Further, this was of the order of the number of chance coincidences as computed for the experiment. The results were, therefore, not at all in harmony with the existing theory, indicating absence of correlation both in time and in direction. As was mentioned in the previous reports these experiments led to many speculations by the theoretical physicists as to the validity of the Conservation laws, for high energy photons.

These negative results obtained by Shankland have, however, been contradicted by Jacobsen, and by Bothe and Maier-Leibnitz on the basis of independent investigations. They used γ-rays from RaTh on account of greater homogeneity. The zero effect i.e., the number of chance coincidences was determined experimentally. For this purpose the β-counter was screened from the recoil electrons, while the counting rate in it was maintained the same as before by a weak source of β-rays, and the coincidences were recorded. Jacobsen used a single β-and a single γ-counter, both of which were placed at 30° to the incident beam in accordance with the theory. The number of coincidences observed, corrected for the zero-effect, was of the same order as anticipated on the theory providing for some defects and imperfections. Bothe and Maier-Leibnitz used almost the same arrangement except that there were two point-counters in series for detecting the recoil electrons. Over and above the observations at 30°, these authors obtained data at directions making other angles with the incident beam, and also with an azimuth of 90°. The coincidences observed with counters at 30° far outnumbered those at other directions. When the azimuth was 90° the coincidences were very few even at 30°. These results show evidently that there is not only the coincidence in time but also there is coordination in space.

In view of these later observations Shankland (*Phys. Rev.* *50*, 571, 1936) has extended his investigations to test the coincidence in time alone. He used a single β-and a single γ-counter and performed two sets of experiments with the counters on the same side or on the opposite sides of the scatterer. The counters were not placed at any particular angle to the direct beam. The experiments were repeated after removing the scatterer. Out of the four sets of experiments the number of coincidences was found to rise abruptly only when the counters were on opposite sides of the scatterer. The author has thereby concluded that there is the correspondence in time.

Correlation in Space

This was observed by Compton himself in collaboration with Simon in 1925 for X-rays. The scattering of X-rays was studied in a cloud chamber in which the recoil electrons were photographed by their ionization tracks. In order to facilitate the recording of photons, lead foils were suspended in the chamber from which photo-electrons might be ejected. With a narrow pencil of X-rays scattered by the gas inside they found that on an average there was one recoil electron for every scattered photon and also that their directions in several cases agreed fairly with the angular relationship deduced from the theory.

Recently the above experiment has been repeated again by Crane, Gaerttner and Turin (*Phys. Rev.*, *50*, 263, 1936) with *hard γ-rays*. They have introduced some fine modifications into the experimental technique and have studied the angular correlation on a wider scale. A mesothorium source of 1 millicurie strength supplied the γ-rays, which were scattered by a thin sheet of celluloid, placed at the centre of the cloud chamber. On either sides of the scatterer were placed two lead screens, parallel to the incident beam, to absorb the scattered photons. A magnetic field was applied perpendicular to the plane of the chamber in order to determine the energy of the recoil electrons from the curvature of their tracks. The expansions were automatic, occurring at 30-seconds interval. In the photographs, the recoil electrons could be recognized by their curved tracks proceeding in the forward direction from the scatterer. The scattered γ-rays after absorption in the lead screens usually appeared as low energy photoelectrons on the outermost side. The authors obtained such a combination of β-and scattered γ-rays in 300 cases out of the total number of

10,000 photographs examined. In each case after finding out the energy of the recoil electron, the direction of the scattered quantum was computed from that of the recoil electron according to Compton's theory, and vice versa. The computed values were next compared with the observed ones. The agreement with the theory was found to be good; the amount of deviation was explicable as due to internal scattering within the scatterer, which was examined in an independent experiment. In the experiment γ-rays of energy from ·5 to 2·5 M. E. V. were used, but the calculations made were independent of the energy of the photons. The authors are, therefore, of opinion that the theory is verified over the entire range, so far as the angular correlation is concerned. These experiments, therefore, prove that the law of conservation of energy and momenta continue to hold in the encounter of γ-rays of RaTh (energy = 2·6 M. E. V.) with electrons.

P. C. Mukherji.

Dewan Bahadur L. K. Anantha Krishna Iyer

Dewan Bahadur Dr L. K. Anantha Krishna Iyer passed away on the 26th of February, 1937, at his residence at Palghat in South India.

He was a great scholar in ethnology. In 1920 he was invited by the late Sir Asutosh Mookerjee to deliver a series of lectures in anthropology at the Calcutta University. His lectures were published by the University of Calcutta with the title "*Lecturers on Ethnography*". He was then appointed as the University Lecturer in Anthropology. He organized the Department and acted as the chairman of the Anthropology board till his retirement in 1932, when late Dr Panchanon Mitra was appointed as the head of the Department. During this period he did extensive researches on the tribes and castes of Mysore which were published by the University of Mysore in four volumes. Besides these he had many other publications to his credit. He was connected with the Indian Science Congress from its very beginning in 1914. He was made the president of the Anthropological section of the Indian Science Congress on five occasions. In 1937 he was also the president of the Anthropological section at Hyderabad.

In 1934 Dr Iyer was invited to deliver lectures at the Universities of Oxford, Rome, Florence, Berlin, Breslau, Hale and Cologne, etc. In the same year in July he also attended the International Congress of Anthropological and Ethnological Sciences in London. There he was a member of the Comite d' Honnor and vice-president in the sections of Ethnology and Sociology. In 1935 he was honoured with the title of Dewan Bahadur by the Government of India and with Officer d'Academic by the French Government. In the same year the University of Breslau (Germany) conferred on him the doctorate degree (M. D.).

He died full of honours, and leaves behind him a large number of relatives, friends, scholars and admirers to mourn his loss.

Minendranath Basu.

Notes and News

Sir J. Russell at the Indian Association

During his recent visit to Calcutta, Sir J. Russell, the famous agricultural expert, received the first award of J. Kissen Mukherjee Medal at the Indian Association for the Cultivation of Science. Sir John later addressed the Association on "Methods in Scientific Research."

He began by pointing out the difference between science and art, and said that while a second-rate artist might make very little contribution to art, a second-rate scientist might render valuable services to the community. Sir John Russell referred to the distinction between pure science and applied science, and said that whereas the latter made use of scientific facts and solved some problems important to the community, pure science, on the other hand, made use of them to explain the various phenomena of the universe. The intellectual activity of the 19th century was essentially constructive when hypothesis and theories and broad simple generalizations were evolved in considerable numbers. Towards the end of that century, the universe seemed to be very simple, governed by a few broad general laws which could easily be stated and easily understood. The 20th century, on the other hand, had been busily occupied.

In overthrowing many of the accepted ideas of the 19th century, practically all of the great scientific generalizations of the 19th century had been discarded. They were shown to be only rough approximations to truth. The 20th century was much more critical. It concerned itself with numerous fine points of measurement and technique. The result was that present-day science was extremely complex—almost unintelligible to the layman—whereas 19th century science could easily be understood by any intelligent person and was a very attractive study.

One of the greatest advances in modern science was the working out of methods for estimating the extent of errors. Sir John gave illustrations to show how by a study of errors it had now become possible to make great discoveries which would otherwise have been overlooked. There had also been an improvement in the method of interpreting results. Modern methods consisted in making full statistical examination of results. These methods had imparted a degree of certainty in the examination of experimental data. That was of greatest assistance to scientists. Calcutta was fortunate in that it possessed a good statistical laboratory, organized by Professor P. C. Mahalanobis, where most modern methods were available for use in scientific investigations. Addressing 'young scientists,' Sir John stressed the necessity of finding time to study the great classical masterpieces of science—the work of investigators, who had opened new realms of scientific study. They, he said, showed the way in which scientific investigation should be carried out, for scientific investigation required that men should ponder carefully and think well. The scientific worker should endeavour to present the results in such a way as could be understood. The great masters of science were always intelligible and anyone who aimed at following scientific career should always study the art of intelligibility. Unfortunately, science students rarely found time to study any language properly and in consequence, they were hardly able to express themselves properly. The result was that science did not receive as much attention in modern life as it should. It was not entirely the fault of the layman. Scientific discoveries, he concluded, opened up great possibilities now as ever before. There was an increasing fund of knowledge which could be either utilized for further discoveries or for solving the practical problems of the community.

Leprosy Relief in Orissa

In the course of his speech inaugurating the Orissa provincial branch of the British Empire Leprosy Relief Association (Indian Council), H. E. Sir John Hubback, said that the position with regard to leprosy had changed greatly from that of 35 years ago when he first came to India. It had been found that leprosy was much more wide-spread than was first suspected, and that the failure to detect it and the anxiety of patients to conceal it were grave menaces to the population as a whole. Against this must be set the happy discovery that the disease is not hereditary, that if taken in time it can be cured and that the danger of infection can be greatly minimized if not entirely eliminated. They were not starting from the beginning in their work, he said. He had visited the two asylums at Cuttack and Puri and clinics at Sambalpur, Joypore, Parlakimedi, and Berhampur where much good work was already being done. Ganjam already had an active district leprosy relief council and he hoped that before the end of the year all districts would have such councils working with the provincial branch.

Lt. Col. G. Verghese, Director of Health and Prisons Services, Orissa, stated that according to investigations which had been carried out in various parts of India, Orissa was one of the most heavily leprosy-infected areas of the country.

"From my own observations," he continued, "I am convinced that there is hardly a village in the whole of Orissa where one does not find at least one or two cases of leprosy. In some villages in some parts of the province the incidence is probably 5 per cent. or 10 per cent. or even more."

" We owe it, therefore," he concluded, "not only to ourselves but to the generations still unborn to evolve a better and happier state of things."

Imperial Institute of Sugar Technology

The Imperial Institute of Sugar Technology, Cawnpore, which was declared open by Sir Frank Noyce on March 11, will commence its first session in July.

An advisory board has been constituted to help the Institute discharge its duties with Sir Bryce Burt, Vice-Chairman, Imperial Council of Agricultural Research as ex-officio chairman and the following members:—

Dr W. Burns, agricultural expert, Imperial Council of Agricultural Research; Mr Brodie, director, Industrial Intelligence Research Bureau; Rao Bahadur T. S. Venkatraman, Government sugarcane expert, Coimbatore; Mr R. T. Shivadasani, director of Industries, U. P.; Dr J. H. Haldane, chief chemist of Messrs Begg Sutherland, Marhowrah; Dr F. Maxwell of the Buland Sugar Factory; Mr. A. Das, Gorakhpore, Mr. J. U. Mulji, president, Bombay Sugar Merchants' Association; Khan Bahadur Muhammad Abdul Aziz, superintending engineer, Irrigation Department, U. P.; and Dr S. S. Bhatnagar, professor of chemistry, Punjab University. Mr R. C. Srivastava, director, Imperial Institute of sugar technology is the member secretary.

COURSES OF STUDY

It is proposed to provide the following courses of study in the Institute:

Associateship of the Institute in Sugar Technology —12 students will be admitted every year, the admission qualification will be a B.Sc. degree and the duration of the course will be three years.

Associateship of the Institute in Sugar Engineering —12 students will be admitted every year, the minimum admission qualification will be a degree of Bachelor in Mechanical and Electrical Engineering and the duration of the course three years.

Fellowship of the Institute in Sugar Technology and Sugar Engineering (research work or design work at the Institute and a thesis to be submitted)—three students will be admitted each year for each section. The minimum admission qualification will be the Associateship of the Institute or an equivalent qualification of recognized institutions abroad and the duration of the course will be two years during the non-working period of cane factories and two seasons' factory experience after qualifying for the Associateship.

Sugar Boilers' Certificate Course—12 students will be admitted each year, the Intermediate Science Examination being the minimum qualification and the duration of the course will be one year and at least two years' practical experience of pan boiling.

Shorter courses will be also provided in the following subjects for men employed in factories and possessing suitable technical and academic qualifications:—chemical control, pan boiling, fuel and boiler control, bacteriology, statistics and the Dutch language.

RESEARCH WORK

The following researches are already in progress at the Institute:—experiments in the treatment of factory effluents, cane drying, milling, different methods of graining in pan boiling, rapid and slow cooling in crystallizers, the efficiency of different types of condensers and keeping-quality of sugars.

Special research schemes are also to be carried out and include the improvement of indigenous systems of making sugar. A research and testing station has been working at Balari, Moradabad district since January, for the testing of and improving existing process and machinery used in the manufacture of *gur*, *rab* and sugar by indigenous systems.

The Bureau of Sugar Standards which started work in March, 1935, will also be attached to the Institute. The Bureau has as its functions the grading of sugar and setting up standards in order to facilitate business and to ensure uniformity in the quality of Indian sugar.

A scheme for investigating the possibilities of utilizing molasses for preparing cattle-feed is also in hand. Balanced cattle-feeds of different compositions are being prepared at the experimental sugar factory with molasses, bagasse screenings and oil cakes and are being despatched to the various animal nutrition centres for feeding trials.

Calcutta University Report

In the annual report of the Syndicate of the Calcutta University for 1936 the question of residence of the Calcutta college students has been discussed.

"During the year," states the report, "about 19,000 students were on the rolls of Calcutta colleges, affiliated to the University including those of the post-graduate classes and of the two Medical Colleges. Of this number about 2,500 or a little over 13 per cent. of the total number were housed in hostels (collegiate and non-collegiate) and in messes (attached and un-attached), licensed by the University. The remaining 16,500 students are to be accounted for. Even if it is assumed that two-thirds of the above number of 16,500 students are residing with parents or legal guardians, still as many as 5,500 students are untraced and it must be assumed that they are living in unlicensed and private messes in contravention of the University Regulations. This is not at all a healthy and desirable state of things, but the problem concerning the residence of these students can only be dealt with by a joint effort in which both the Government and the different colleges concerned must take their share."

Regarding the University Students Information Bureau, the report states—"During the period under review there had been a large number of inquiries by letters for admission to the different educational institutions and engineering works in the U. K. Apart from such inquiries by letters the Bureau had to deal with a considerable number of verbal inquiries. The total number of inquiries during the period under review had been much larger than previous years—while during the last term the number was near about 300, this year the number of inquiries amounted to 486. In doubtful points information was secured from the High Commissioner's Office and was placed before the applicants.

"One characteristic feature of the year happens to be a tendency among the applicants to qualify themselves for an educational degree or diploma. Formerly the largest number were attracted by the engineering and technology section and general degree section, but it appears that a qualification in the methods of teaching is considered to be of value by the applicants. Besides education, agriculture also has been another subject which has been taken up.

"Regarding post-graduate studies, the numbers are now on the increase which embraces not only branches of arts and science, but also of soil science, plant breeding and other fundamentals of agriculture. Aviation experience has also been sought for by a number of candidates and facilities had been provided for them in some of the leading establishments in Great Britain. On the whole it is felt that there had been this year especially a greater tendency of our students to proceed to U. K. for getting a training in applied sciences specially with reference to agriculture."

C. P. Government and Unemployment

The Commerce and Industries Department of the Central Provinces Government, which has examined the recommendations of the Unemployment Committee of the United Provinces, has suggested the drawing up of a scheme for the industrial and economic survey of the province with the establishment of research workshops in the Science College and Engineering College laboratories by way of a beginning.

With regard to the recommendation made by the Sapru Committee that opportunity should be afforded to students who have qualified as engineers for receiving practical training in firms, the Department observes that in C. P. there is no scope for action on this recommendation as there was no institution in the province which trains students in electrical engineering.

There is, however, scope in the oil industry, says the Department, in view of the decision of Nagpur University to establish the Laxminarayan Oil Technological Institute.

A subsidy of Rs. 20,000 annually to the Nagpur Museum for giving expert advice to cottage industrialists and for carrying on experimental research work is urged while a scheme costing Rs. 1 lakh for the financing and the marketing of cotton industries in the province is considered suitable for adoption if and when funds permit.

The scheme to foster the organization of co-operative stores employing educated men is not however considered suitable as also the establishment of a joint stock bank.

The deputing of a special officer to study the working of the Bengal scheme intended to help educated men to start small industries is recommended should funds permit while the establishment of an Employment Exchanges Bureau under the control of the Education Department or the University of Nagpur is favoured.

The Department also examined the question of restoration of posts which have been retrenched but sees no need for restoring any posts at present. It, however, suggests the appointment of a Deputy Director of Industries to enable the Department to undertake technical investigations.

Regarding the prescribing by Government of their own standards for entry into Government services in the cases of subordinate services and recruitment of new men through competitive examinations or by selection, the Department does not see any need for changing the present method of recruitment. It, however, suggests that the age limit of 25 years for entry into subordinate services should be reduced to 20 years so as to eliminate candidates with high academic qualifications for the ministerial posts.

In conclusion the Department points out the difficulty of taking immediate steps in many of the Sapru Committee's recommendations, which it favours, owing to a lack of funds.

Extension of Calcutta Medical College Hospital

A Casualty Ward fitted with up-to-date equipments is the latest addition to the Calcutta Medical College Hospitals. The new ward which is to be named as "Sir John Anderson Centenary Block" was recently opened by H. E. Sir John Anderson in the presence of a distinguished gathering. The Block as at present constructed contains 40 beds—24 for males and 16 for females—and includes observation wards, post-operative rooms, separate and spacious examination rooms, modern operation theatres, X-ray hall, and a large fracture room. Suitable accommodation has also been provided for emergency medical officers and also for male and female students who will thus receive training in proper environments. The scheme for the construction of a casualty ward was conceived on the occasion of the Medical College Centenary Celebrations and its foundation stone was laid by H. E. the Governor on January 28, 1935.

In the course of his speech requesting the Governor to declare the Block open, Sir B. P. Singh Roy, Minister for Local Self-Government, said:

"Sir John Anderson Casualty Block will form a very important link in the gradual expansion of the Calcutta Medical College Hospitals expansion, which started with the additions of 3 Wards in 1844, accommodating 112 beds. The next period of development of the Hospital was between 1852 to 1858, when the oldest existing block of Hospital in the present compound was opened with 350 beds. During the year

1880 to 1898 the Shyama Charan Law Eye Infirmary, the Ezra Hospital, the Chunilal Seal Outdoor Dispensary were added. In 1899 the Medical College group of hospitals provided 449 beds. It was during the year 1899 and the following years that the proposal of building a modern surgical hospital was taken up and it resulted in the opening in 1910 of a separate commodious modern surgical hospital known as the Prince of Wales Hospital with 88 beds in commemoration of the visit to Calcutta of His Royal Highness the Prince of Wales in 1906. The present accommodation in the Hospital consists of 698 beds including 139 in Raja Debendra Mullick Eye Hospital which was one of the latest additions to the Medical College group of Hospitals. The new Casualty Block will remove one of the most urgent needs in the Hospital accommodation and will add to its amenities. The expansion of the Calcutta Medical College Hospitals has been largely due to public munificence and on this occasion too the tradition of charity of the people of Bengal and Calcutta has been well-maintained."

Nutrition

During recent years the all important question of human nutrition has been receiving attention the world over. In India, also, especially since the assumption of the Viceroyalty by His Excellency Lord Linlithgow, there is evidence of a growing public interest on the subject, thanks largely to the emphasis which His Excellency laid when opening the session of the Nutrition Research Committee of the Indian Research Fund Association in Simla last summer, on the practical human importance of the subject. On this occasion His Excellency the Viceroy emphasized the need of practical application in the homes of the people of the fruits of research work in terms of the diet of both the rural and urban populations. He also referred to the proposals envisaged by the Royal Commission on Agriculture and endorsed by the Royal Commission on Labour for setting up a Central Institute of Nutrition. He particularly remarked on the need of establishing a link between research on the problems of human nutrition and those of agriculture and invited the members to consider the expediency of establishing a point of contact between these two branches of science.

It will, therefore, be of interest to indicate briefly the steps which have recently been taken to make a beginning at least in giving effect to this policy. While India had in Sir Robert McCarrison and has now in his successor Dr Aykroyd specialists of eminence, the ordinary machinery of Public Health administration dose not include Public Health officers with a special knowledge of its technique or special training for propaganda or other activities aiming at the practical application of the results of laboratory investigations. This was perhaps natural in the early years of nutrition work, as the first objective obviously was to get together the scientific data on which practical work extending to the homes of the people could be based. This material having been brought together by the labours of Sir Robert McCarrison and his associates both in the laboratory and the field the time is now ripe for a move to popularize these results.

As a first step, the Indian Research Fund Association have arranged to hold a three months' course of training during April to July, 1937 at the Nutrition Research Laboratory in Conoor for officers deputed by the Central and local Governments so that every Government may be enabled to have at least one officer in its Public Health Department with special knowledge of the subject. Secondly, the Indian Research Fund Association have, on the recommendation of the Nutrition Advisory Committee, created a post of expert in human nutrition who will work in the Imperial Agricultural Research Institute. His function will be to link up the results of nutritional research on the medical side with agricultural activity so as to permit of agricultural practice being adjusted to the nutritional requirements of the population. Another proposal, which is under active consideration, is the appointment of an Assistant Director of Nutritional Research who will take charge under Dr Aykroyd of some of the experimental and research work now being supervised by the Director and the appointment of a limited number of field workers. Lastly, the subject of propaganda, or as His Excellency put it, the need for practical application in the homes of the people of the fruits of research is also being energetically pursued.

In 1928 Sir Robert McCarrison published a small book entitled *Food* which has gone through several editions and which has been also translated into a number of vernacular languages. This book has been widely used by those in charge of hostels, boarding schools and similar institutions and has been of great value to those concerned in improving the diets of the children under their charge, especially when finances have forbidden any large additional costs. Recently Dr Aykroyd has prepared a Health Bulletin which gives the results of his more recent work in connection with the analysis of 200 common Indian food stuffs. This bulletin will, it is hoped, form a valuable mine of information from which it will be possible for public health administrators to extract material which can usefully be issued in leaflet or pamphlet form in the local vernaculars. Other brief notes such as those recently issued from the Nutrition Laboratory at Conoor on the value of skimmed milk are being issued at intervals. In these several ways, it is hoped to pass on acquired knowledge so that those interested may use that knowledge for the benefit of the general rural and urban populations of the country.

Sir S. M. Sulaiman on University Education

In his recent Convocation address of the Osmania University, Hyderabad, Sir Shah Mahammed Sulaiman, Chief Justice, High Court of Judicature, Allahabad, devoted a part of his speech to the necessity of remodelling the present system of university education. Instead of calling in the financial aid of the State, the Indian universities should "grade down the salaries of the teaching staff and grade up the fees charged from scholars, so as to make the two commensurable with one another, as in the case of British universities which have the experience of centuries behind them". He, therefore, suggests a rearrangement of the scale of university fees charged: the first divisioner to be free from tuition fees altogether, the second divisioner to pay his fees at the existing rate, and the third-class student to be charged double the amount for his university education. Such a graduated scale of fees would increase the revenue and put an indirect check on indiscriminate admissions. "University education should be broadened on a new system of secondary education which, in addition to giving students a literary and cultural education, should also qualify them for particular callings and professions, so that instead of unnecessarily prosecuting their studies further they may early direct their energies to commercial and industrial pursuits, with a better chance of earning a decent livelihood."

Mr K. P. Chattopadhyay

We are glad that Mr K. P. Chattopadhyay, Eudation Officer, Calcutta Corporation, has been appointed head of the Department of Anthropology of the Calcutta University. He is a noted anthropologist of India and has done valuable research work in the subject. He was the President of the Section of Anthropology in the Indian Science Congress a few years ago.

Science in Industry

The Nickel Industry in 1936

An annual survey prepared by Robert C. Stanley, President, the International Nickel Company of Canada, Ltd., states that statistics for the first ten months of 1936 indicate that this year will establish new records for the industry in the volume and diversification of world consumption. This consumption of nickel in all forms attained a total of some 162,000,000 pounds, an increase of more than 20 per cent over the corresponding period for 1935 and compares with 112,000,000 pounds in the first ten months of 1929. The steel industry, which is the dominant consumer of nickel, broadened its markets and in consequence substantially increased the use of nickel alloy steels. New compositions of nickel alloy steels in the form of sheets, plates and other mill products for structural purposes, not available heretofore, are now being marketed in considerable tonnages under a long list of trade names. Of interest have been the advances made in the stainless steel industry during the past year. Not only is more nickel being used, but the standards of quality of finished sheet and strip produced by the principal manufacturers are being steadily raised. In addition to these two conventional products in the stainless steel series of alloys there is a marked increase in output of wire and tubes, and the production of special alloy compositions suitable for machining has further expanded consumption. Consumption of nickel in plating is making notable strides especially in Europe. This is being stimulated further by the advent of bright plating. While still in the early stages of application in the United Kingdom and in Europe generally, the process is making substantial progress in the United States. Thus, nickel flows in various forms through an increasing diversity of channels into the industrial processes of the world.

—*Journal of the Frank. Inst.*

Manufacture of Sulphuric Acid

A way in which India might manufacture sulphuric acid from indigenous resources is suggested in a bulletin issued recently by the Industrial Research Bureau of the Government of India.

One of the basic chemical needs of industry is sulphuric acid, and at present all the sulphur required for the manufacture of sulphuric acid in India has to be imported. Recently prizes were offered by the Industrial Research Bureau for research papers of value to Indian industry. Among those to receive a prize was a paper submitted by three people—Dr V. S. Dubey, M. B. Rane, and M. Kanakaratnam, who dealt with the preparation of alumina and sulphur dioxide from bauxite-gypsum mixtures.

In their report, the authors point out that the only material containing sulphur available in large quantities in India is gypsum. They conducted a number of experiments which proved that it is possible to obtain sulphur dioxide from mixtures of gypsum and bauxite heated to high temperatures. Not only is sulphur dioxide obtained, but also quantities of alumina, from which aluminium and aluminium salts may be manufactured.

Television Exhibition

The first public exhibition devoted solely to the development and modern attainments of television is to be opened at the Science Museum at South Kensington early in June. It is expected that the exhibition will remain open for three months. All the principal British manufacturers interested in the development of television are co-operating with the Radio Manufacturers' Association, and the B. B. C. to make the exhibition truly representative, and it is expected that it will do much towards spreading a wider appreciation and understanding of modern television.

The history of television may be said to date from the year 1873 when a telegraph operator named May discovered that the electrical resistance of the metal Selenium was altered by light, and ever since

1880 experimenters have attempted to send pictures and scenes, first by wire and then by wireless. It is only now, however, that the development of apparatus and technique have made possible the inauguration of an official television broadcasting service on a high definition standard.

The exhibition at the Science Museum will illustrate the development of the subject and will show the simple principles of modern television. In addition, demonstrations will be given of the B. B. C. programmes on modern receivers and a local transmitter will be shown in operation so that the receivers can operate when no B. B. C. transmission is available.

The World Production of Aluminium

The world production of aluminium was increased by 50 p.c. in 1935 as is seen from the figures: 259,000 tons in 1935 and 170,800 tons in 1934. Of this increased production 58,800 tons came from Europe and 25,600 tons from America. In Europe the increase of production was mainly due to Germany (70,000 tons in 1935 as against 37,200 tons in 1934), but Russia also contributed a large part. In 1931 Russia produced only 100 tons of aluminium, but this production increased to 14,400 tons in 1934 and 24,500 tons in 1935. During the last two years Sweden and Hungary have entered the field of aluminium production (1,800 and 300 tons respectively in 1935). For the figure of aluminium production in 1936 the increased production in Italy must be taken into account. It is now only a question of time that Holland, Yugoslavia and Czechoslovakia establish their national industry of aluminium.

Outside Europe, Japan has increased her aluminium production in a remarkable manner: 700 tons in 1934 and 4,700 tons in 1935. In U. S. A., the production attained its maximum in 1930 with 103,900 tons, but in 1935 it fell down to 54,100 tons.

The following table gives the figures of production (in thousands of tons) of aluminium in different countries during the last few years:

	1929	1932	1933	1934	1935
Germany	33.3	19.2	18.9	37.2	70.7
Russia	——	0.9	4.4	14.4	24.5
France	29.0	14.5	14.5	16.2	21.8
Norway	29.1	18.0	15.5	15.5	16.0
Great Britain	13.9	10.3	11.0	13.0	15.1
Italy	7.0	13.4	12.1	12.5	14.0
Switzerland	20.7	8.5	7.5	8.2	11.7
Austria	2.7	2.1	2.1	2.1	2.5
Sweden	——	——	——	0.3	1.8
Spain	1.0	1.1	1.1	1.2	1.3
Hungary	——	——	——	——	0.3
Other European Countries	——	0.1	0.1	0.1	0.1
Europe (total)	136.7	88.1	87.2	121.0	179.8
U. S. A.	102.1	47.6	38.6	33.6	54.1
Canada	4.2	18.0	16.2	15.5	20.6
America (total)	106.3	65.6	54.8	49.1	74.7
Japan	——	——	——	0.7	4.7
Total	280.8	153.7	142.0	170.8	259.2

Contrary to what has been said for the production, the consumption of aluminium reached its maximum in 1935: 276,000 tons in 1929 and 307,000 tons in 1935. Germany is the greatest consuming country. The following table gives the consumption of different countries in the last few years:

	1929	1932	1933	1934	1935
Germany	39.0	19.1	28.3	52.5	87.0
Great Britain	30.0	17.5	19.0	23.0	28.4
Russia	6.0	11.5	15.0	19.5	25.0
France	25.0	15.0	14.0	18.0	24.0
Italy	9.3	5.5	7.3	9.4	15.0
Switzerland	8.0	4.5	5.5	6.5	7.0
Other European Countries	8.0	6.0	9.0	10.0	12.2
Europe (total)	125.3	79.1	98.1	138.9	198.6
U. S. A.	130.0	48.0	50.0	74.0	87.6
Canada	7.0	5.0	4.0	5.5	5.2
Other American Countries	7.0	5.0	1.5	1.5	1.5
America (total)	137.0	58.0	55.5	81.0	94.3
Japan	13.0	5.3	4.0	5.8	12.5
Other Asiatic Countries	13.0	0.7	0.6	0.8	0.8
Australia	0.7	0.2	0.2	0.4	0.8
Total	276.0	138.3	158.4	226.9	307.0

T. C. S. from Nouvelles de la Chimie.

The World Production of Mercury

The production of mercury attained its maximum in 1929 with 5600 tons; it fell down to 200 tons in 1933 and again increased to 3400 tons in 1935. 90 p.c. of this production come from Europe. In 1924 Italy occupied the third place among the mercury-producing countries, coming after Spain and U. S. A., but owing to greater demands it has doubled its production and now occupies the second place, the first place being retained by Spain. The following table gives in tons the production of mercury in different countries:

	1934	1935
Spain	1096	1232
Italy	441	880
U. S. A.	532	604
Russia	267	300
Mexico	158	216
Czechoslovakia	26	69
China	102	45
Bolivia	19	15
Other Countries	14	17
Total	2652	3378

The market is supplied chiefly by Spain and Italy: Mexico has equally increased its export in 1935. In 1933 Spain exported 2288 tons of mercury; of this 688 tons went to England, 522 to Belgium, 349 to U. S. A and 240 to Germany.

It may be recalled here that the Spanish Italian cartel of mercury ended in 1936. It had been established in 1927 in order to maintain the high price of mercury of that time (£ 20 for a bottle of 35 Kilos) as also to fight against American and Mexican competition. These objects, however, were not attained; the price fell down to £12-£18 in 1935 owing to the greater consumption by Italy in time of the Abyssinian war. As to foreign competition, it goes on developing.

Just at present the exploitation of the mines at Almaden in the province of Cindad Real has not been affected by the Spanish civil war, as has been the case with the copper mines of Rio Tinto, the metallurgical mines of Biscay and the collieries of Austuries. Even if the Spanish production of mercury is totally suspended, Italy, U. S. A., Mexico, and Russia would be able to supply 3000 tons, which figure represents the average consumption of the last five years.

T. C. S. from *Nouvelles de la Chimie.*

Ghee Analysis

Ghee forms such an important item in the Indian dietary that a thorough chemical investigation of its nature is of great importance. Such investigations are all the more important because ghee is so often sold in the market in an aduterated form with serious consequences on the public health. We are glad to publish below an article on ghee-analysis by Professor N. N. Godbole who is a well-known worker on the subject and Mr V. V. Ketkar.

Evolution in the Chemical Methods of Ghee Analysis from *Reichert Meissl Value* (1879) to *Butyric Acid Number* (1927), and its Modification (1935)

N. N. Godbole
Professor of Industrial Chemistry, Benares Hindu University.
V. V. Ketkar

Ghee or butterfat is the fatty portion separated from the milk of a cow or a buffalo. It is well known that ghee forms an important and necessary nourishing food article, especially to the vegetarian in India, and very large quantities are consumed. Due to the high price of butterfat as compared with the other oils and fats, fraudulent adulteration of butterfat is profitably carried on by dealers, on a very large scale. The problem of determining the purity of butterfat is thus of very great importance. The adulterants[1] mostly used are cocoanut oil, mohua, hydrogenated oils, etc. Like all other oils and fats, butterfat is a mixture of glycerides of various fatty acids. The proportion of the constituent fatty acids in the total fatty acids of an average sample of butterfat is given below.

Table No. I.

Name of acid.	Proportion* Average.	Butterfat.**	
		Cow.	Buffalo.
Butyric	3.1 — 3.4	4.0	4.0
Caproic	1.7 — 1.9	2.0	2.0
Caprylic	0.8 — 0.9	0.9	0.9
Capric	1.9 — 2.8	2.0	2.0
Lauric	3.1 — 4.8	4.5	4.0
Myristic	9.7 —10.8	10.0	9.0
Palmitic	27.6 —28.4	26.0	31.0
Stearic	8.5 —12.2	10.0	12.0
Oleic	33.1 —36.4	34.5	30.0
Linoleic	3.7 — 5.4	5.0	4.0
Arachidic	0.5 — 1.0		
Unsaponifiable		1.0	0.45
Total		99.9	99.35

* Hilditch & coworkers: *Analyst 54*, 75, 1929; *55*, 75, 1930.

** Godbole & Sadgopal: (Extract from the *Thesis*, submitted to the B. H. University, for the Doctorate degree)

From the data given above, it can be seen that butterfat differs from most of the other oils and fats in two respects. Firstly the content of the lower fatty acids up to C_{10} is high, and secondly butyric acid is present to the extent of about 3.5%. Most of the chemical methods for the estimation of butterfat are based on these two important and characteristic values, besides the determination of the refractive index also.[2]

One of the important methods for the separate estimation of the individual constituent fatty acids of an oil or fat, is the method of separation of the methyl esters of the fatty acids by fractional distillation under reduced pressure. This method is however very laborious and requires a large quantity of the sample under examination. The first practical method proposed for such work (estimation of butterfat, cocoanut oil, palmkernel oil etc.), which can be carried out on a small sample, was enunciated and carried out by Reichert.[3] This method with the modifications of Meissl and Polenske is widely used for the estimation of butterfat, cocoanut oil and palmkernel oil. The method is based on the estimation of a definite portion of the steam-volatile fatty acids, obtained under definite empirical conditions. The detailed method is given below.

Estimation of the Reichert Meissl and Polenske Values[4]

Definition: The Reichert Meissl value is represented by the number of c.c. of N/10 alkali required to neutralize the steam-volatile and water-soluble fatty acids obtained by the prescribed method, from exactly 5 gms. of the fat or oil.

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[1] Godbole and Sadgopal: *Butterfat*, p. 9, 1930.

[2] Godbole and Sadgapal *Butterfat* p. 27. 1930.

[3] Reichert: *Ztschr. analyt. Chem. 18*, 86, 1875.

[4] Wizoff, *Einheitliche Untersuchungsmethoden fur die Fett-und-Wachs Industrie*, 1930, p. 85-87.

The Polenske value is represented by the number of c.c. of N/10 alkali required to neutralize the steam-volatile and water-insoluable fatty acids obtained by the same procedure from exactly 5 gms. of the fat or oil.

Procedure: Exactly 5 gms. of the sample are weighed out into a 300 c.c. round bottomed Jena flask, and are saponified over a direct flame, with 2-4 c.c. glycerine and 2 c.c. of aqueous KOH (50%). The saponification is carried out with care and *without overheating*, until the contents of the flask are quite clear. When the contents have cooled to 80°C., 90 c.c. of freshly boiled water at the same temperature are added. To this, 50 c.c. of dilute sulphuric acid (25 c.c. of con. H_2SO_4 per litre) and 0.6 to 0.7 gm. of pumice powder are added. The flask is immediately closed and the contents are distilled in the prescribed apparatus in such a way that 110 c.c. of the distillate are obtained in 19 to 21 minutes. When exactly 110 c.c. are received, the flame is removed and the receiver is replaced by another clean vessel. The receiver is dipped in water at 15°C. for 10 minutes. The distillate is then shaken thoroughly and filtered through a smooth dry filterpaper having a diameter of 8 cms. If the filtrate is not perfectly clear, it is shaken with a little kieselguhr and refiltered through the same filterpaper. 100 c.c. of the filtrate are titrated with N/10 alkali using 3 to 4 drops of a neutral alcoholic 1% solution of phenolphthalein as an indicator. A blank is also carried out. *Calculation*: R. M. value = 1.1 (a-b), where a = c.c. of N/10 alkali req. in the main expt. and b = c.c. of N/10 alkali req. in the blank expt.

Procedure for R. P. Value

In order to remove completely the water-soluble fattyacids, the condenser, the second receiver, and the first receiver are washed successively three times, using 15 c.c. of water each time. Each 15 c.c. of wash water are filtered through the filterpaper previously used. In order to dissolve out the remaining water-insoluble fatty acids, the above mentioned vessels are washed with 90% neutral alcohol in an exactly similar manner, and the wash-alcohol passed each time through the filterpaper. It is to be remembered that the second and the third 15 c.c. of alcohol are transferred to the filterpaper, only when the first and second have completely drained out of the filterpaper. The total alcoholic solution is titrated with N/10 alkali as before.

Calculation: Polenske Value = c.c. of N/10 alkali req. for the titration.

The Drawbacks and Shortcomings of the R.M. and R. P. Values as applied to Butterfat Analysis[5]

"The classical method for estimating the purity of butterfat and cocoanut oil, is the determination of the R.M. and R.P. values. The procedure of the method is such that the actual results obtained are quite different from those theoretically aimed at.

The distillation of the fatty acids proceeds from beginning to end in a three phase system:
Aqueous solution/ Insoluble fattyacids/ vapour phase.

The insoluble fatty acids behave as a powerful solvent towards the fattyacids in the aqueous solution. The result is that the volatilization of the watersoluble fattyacids is checked. In a similar manner the volatilization of the waterinsoluble fattyacids is also hindered. The yield of the total volatile fattyacids is thus much less than the theoretical amount expected. The agitation of the waterinsoluble fattyacids by the stream of water vapour, which takes place while the distillation proceeds, has an undesirable effect. Lauric and myristic acids distil over to an appreciable extent, while palmitic acid can also be detected in the distillate. Cocoabutter which does not contain even traces of lower fatty acids, gives a small Polenske value due to the reasons mentioned above.

"The separation of the watersoluble fatty acids from the water insoluble ones is done by simple filtration, with the result that the insoluble portion contains traces of butyric and caproic acids, while the soluble portion contains most of the butyric and caproic acids appreciable quantities of caprylic acid, and measurable quantities of capric acid. Thus butyric, caproic, caprylic, and capric acids are estimated partly in the soluble portion and partly in the insoluble portion. The size and shape of the dis-

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5. J. Grossfeld: *Fette und Seifen*, July, 1936, pp. 100-101.

tilling arrangement greatly influences the R.M. and R.P. values, which is a great disadvantage.

In order to effect a more complete separation of the fatty acids which are characteristic for butterfat and cocoanut oil, two artifices are generally employed.

(1) Separation of the water-soluble fatty acids from the water-insoluble ones by filtration before distillation.

(2) Separation of the higher fatty acids by precipitation of their Mg soaps by means of Mg SO4 solution.

The first artifice is employed with a special modification by Grossfeld for his *Butyric acid value.*[6]

The second artifice has been employed by S. H. Bertrâm and his co-workers for estimating the *A and B values.*[7]"

From Reichert Meissl to Butyric acid value[6]

After Reichert, a good many workers in the field have devised methods for the estimation of butterfat and cocoanut oil, depending upon more or less similar principles. Most of the earlier methods have been given up in favour of the more recent improved methods. All these methods[8] are given below in the order of their sequence.

Methods based on the separation of the silver soaps.

1.	Caprylic acid value	Jensen	1905
2.	Capric acid value		
3.	*Kirschner value*	Kirschner	1905
4.	First and second Silver value	Wijsmann	1906
5.	First and second caprylic value	Dons	1907
Other metallic salts			
6.	Copper value	Bellier	1907
7.	Cadmium value	Paal & Amberger	1909
8.	Baryta value	Firtsch	1907
		Ave Lallement Ewers	1910
9.	*A and B values*[7]	Bertram, Bos and Verhagen	1928
10.	*Butyric acid value*[6]	J. Grossfeld	1927

The R.M. and R.P. values and the Kirschner[9] value have been uptil now the classical methods for the estimation of butterfat. The description of the Kirschner value also is therefore given below ***in detail.***

The Kirschner value represents the number of c.c. of N/10 alkali required to neutralize the R.M. fatty acids (cantaining a specified quantity and obtained under definite conditions) the silver salts of which are soluble in aqueous solution. This value, therefore, primarily represents the amount of butyric acid contained in an oil or fat, but is *liable to an error due to the presence of caproic acid.* Caprylic acid and the higher homologues are however without any influence.

Procedure: 100 c.c. of the distillate *as obtained in the R.M. apparatus by the R.M. procedure* are neutralized with N/10 baryta solution, and 0.5 gm of finely powdered silver sulphate is added. The mixture is allowed to remain for one hour with repeated shaking. The liquid is then filtered, and 100 c.c. of the filtrate are transferred once again to the R.M. distilling apparatus. 35 c.c of water are added along with 10 c.c. of dilute sulphuric acid (20.25 c.c. conc. H_2SO_4 in litre) and a long piece of aluminium wire. 110 c.c. are then distilled in 20 minutes. 100 c.c. of the distillate are then titrated with N/10 NaOH solution, using phenol-phthalein as the indicator. A blank test is carried out in a similar way. The Kirschner value is calculated for 5 gms of the fat, as follows:—

a = c.c. of N/10 baryta solution required.
b = c.c. of N/10 NaOH solution required for the end titration minus that required for the blank titration.

$$\textit{The Kirschner value} = \frac{b \times 121\ \overline{(100+a)}}{10}$$

The Kirschner value has often been described[10] as a value as useful as the B value. It is however not so since the determination of the Kirschner value is based on the estimation of the butyric acid obtained in *the distillation by the R.M. method, the defects and inaccuracies of which have been discussed above.* The

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[6] J. Grossfeld und J. Kuhlmann : *Z. Unters. d. Lebensmittel*, *51*, 31, 1926.

[7] S. H. Bertram, H. G. Bos, and F. Verhagen : *Chem. Weekbl.*, *20*, 610, 1923 ; *Chem. Zentralbl.* 50, 244, 1925.

[8] Grün : *Analyse der Fette und Wachse* vol. 1. p. 169, 1925.

[9] Kirschner : *Z. Nahrgsm.* Bd. 9. p. 65, 1905 ; Grün : *Analyse der Fette und Wachse* vol. 1. p. 170 1925.

[10] Herbert Hawley, p. 815-817, *Current Science*, May 1936.

A. and B. values are a development *on all the older values including the Kirschner value.* It has been pointed out in the discussion on the R.M. procedure, that the separation of the lower fatty acids as water-soluble and water-insoluble ones involves *certain fundamental errors.* These errors are eliminated in the case of the fractional precipitation method as followed in the A and B value [7] procedure.

One outstanding advantage of the A and B values over the similar and older values, is the very narrow range found for pure samples of butterfat. A comparative table of the R.M., R.P. and A. and B values of a number of butterfat samples of known purity, is given below. (Results not yet published).

A Tabular Statement for R. M. R. P. and A and B Values of the Same Samples of Butterfat

Table No. II.

Source.	R.M. value.	R.P. value.	A-value.	B-value.
Cow	21.0	0.7	6.8	33.0
„	23.3	0.75	6.5	33.3
Buffalo	24.6	0.85	6.8	35.0
Cow	26.4	1.74	6.3	32.85
„	27.0	1.8	6.4	33.5
„	27.75	1.15	6.8	31.0
„	28.6	0.85	6.2	33.0
„	29.2	1.1	6.2	33.3
Buffalo	29.85	1.05	6.4	33.0
Cow	30.76	0.9	6.3	33.2
„	31.0	1.5	6.2	34.0
Buffalo	32.5	1.75	6.5	35.5
„	33.55	1.85	6.35	35.0
„	34.0	1.35	6.5	34.0
„	35.0	1.6	6.6	35.5

(*Note*: The above values have been quoted from the manuscript in press of the revised edition of the book on butterfat by Prof. Dr N. N. Godbole and Mr. Sadgopal, M.Sc. of Benares Hindu University).

Some critics of the A. and B. values have referred to results quoted by König,[11] in order to show that the *B* values of certain samples of butterfat vary within wide limits.

Dr. Bleyberg referring to this quotation from König writes to us as follows.

Extract from the letter to Dr. Godbole.

"I have looked up König's book, at the library of the Deutsche Chemische Gesselschaft.

As to passages quoted by your critic, the following data occur on p. 720 of vol. 2 in the following form:

The A value is (b) For butterfat—6.7—7.1.

The B value is (a) For butterfat 26.7—48.1

If you compare these figures with those given in Holde's 6th edition, p. 623, table 151, you will see that they only represent a summary of Bertram's own figures quoted in Holde's table, but unfortunately König's summary contains two mistakes: 1. The lower limit (26.7) is obviously a misprint for 29.7, which would correspond to Holde's figure of 29.67; 2. König entirely overlooks the fact that the extraordinary high value 48.18 of butterfat no. 5 relates to rancid Australian butter and, therefore under no circumstances ought to be included in the range of normal butterfats. *Consequently both of the limits given by König for B-values of butterfats are wrong.*"

The butyric acid value is a development on all the other values mentioned above. The procedure for the determination of this value is given below.

Butyric Acid Value[6]

The butyric acid value stands for the no. of c.c. of N/10 alkali required to neutralize the amount of acid obtained by distillation from 5 gms of a fat which after saponification in aqueous solution is saturated with sodium sulphate and caprylic acid, and acidified with sulphuric acid.

Procedure: 5 gms of the fat under investigation are saponified with 2 c.c. of aqueous KOH solution (750 gms KOH in litre), and 10 c.c. of glycerine in a 300 c.c. round bottomed flask, carefully over a free flame. The clear soap solution is allowed to cool a little, and diluted with 100 c.c. of distilled water. After cooling the solution to about *20-30°C*, 30 c.c. of dilute sulphuric acid(25 c.c. conc. H_2SO_4 in litre) are added. Now 15 gms of anhydrous sodium sulphate are gradually added and dissolved in the mixture, and 10 c.c. of a 10% *cocoanut-soap solution* are added.

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[11] König: Untersuchung landwirtscha ftlich u. land w. gewerblich wichtiger Stoff, Vol. II, p. 720.

[*Preparation of the cocoanut soap solution*: 10 gms of pure cocoanut oil (known in Germany by the trade name of *Palmin*) are saponified with 4 c.c. of aqueous KOH solution of the same strength as that used above, and 10 c.c. of glycerine in a Jena flask. When the saponification is complete, the soap is allowed to cool and is then diluted to 100 c.c. with distilled water. (*"We have used Tomcos pure cocoanut oil as a substitute for palmin and found it be perfectly suited for the experiments."*)—AUTHORS.]

After adding the cocoanut soap solution, 0.1 gm of kieselguhr is added and the mixture is shaken for about 10 minutes. The mixture is then filtered through a dry fluted filter paper having very fine pores. The filtrate thus obtained must be perfectly clear.,

125 c.c. of this filtrate and 50 c.c. of distilled water are taken in a 500 c.c. round bottomed distilling flask. Some pumice powder is added and the liquid is distilled until 110 c.c. of distillate are obtained. The distillate is titrated with N/10 alkali, (indicator 1% phenol phthalein).

Butyric acid value$=1.4$ (a-b);

where a=c.c. req. for the main titration,
and b= „ „ „ „ blank „

The butyric acid value for butterfat is about 20, and for cocoanut oil about 0.9. The butyric acid value corresponds to the proportion of butyric and caproic acids which are characteristic for butterfat. The separation of the butyric and caproic acids from the other acids is made sharp by prctically saturating the solution with Na_2SO_4, (K_2SO_4 also serves the purpose) and caprylic acid. The error which might have arised from the caproic acid in the cocoanut soap is balanced by the same amount of caproic acid in the blank experiment.

A number of trials have recently been taken in the B.H.U. laboratory on the estimation of the *Butyric acid number*, with the help of some standard butters from the Indian market. The values obtained (in each case an average *of two tests*) are quoted below.

Some Experimental data on the Estimation of Butyric Acid Value

Table No. III.

Sample.	Butyric acid value.
1. From Polson's butter	
(August sample)	26.0
2. (September sample)	25.7
3. (October sample)	25.7
4. (November sample)	25.9
5. From Lord's butter	25.1
6. „ Dairy butter of the Agricultural Institute of Allahabad	24.1

It is interesting to note that whereas European samples of butter, as quoted by Grossfeld,[5] give a butyric acid number of about 20, (and 18—20 as given on page 85 of the *Milchwirtschaftliches Taschenbuch*—1936), the Indian samples, examined so far, give an average of about 25.2. One possible explanation is to be found perhaps in the fact that most of the Indian cows and buffaloes are fed very largely on green grass and leaves (particularly in the months of August, September, etc. see table No. III) and therefore they show a greater content of butyric and caproic acids; whereas, the European butters obtained from *cows* fed *on cakes*, yield more of the higher glycerides and less of the lower ones. As the number of samples tested so far in this laboratory is small it would not be advisable to arrive at any definite conclusions. Further work on this subject is in progress.

Research Notes

Magnetic Moments of Neutrons

The neutron which is the latest element discovered by Chadwick in 1932 continues still to puzzle the investigators on account of its strange and unexpected physical properties. A popular conception of neutron may be obtained from the idea that if in the hydrogen atom, the electron fall into the nucleus, it will form a neutron. The neutron has thus a mass which is equal to that of hydrogen and it has no charge. The investigators first thought that the neutron would give all the properties which we can think about this neutralized hydrogen nucleus but later experiments showed that these predictions were not fulfilled. For according to this conception neutron should have a mass which is less than the combined mass of the proton and the electron. It should have little or no magnetic moment, and spin should become zero or one. But Aston showed conclusively that the mass of the neutron is about one electron-mass higher than the combined mass of the proton and electron. The conception has therefore gained ground that the neutron can exist only in the nucleus as such and a short time after it comes out of the nucleus, it dissociates spontaneously into a proton and an electron. In other words the neutron itself is radioactive. No method can possibly be found out by which this interesting speculation can be verified. Further the spin of the neutron was shown by Heisenberg to be just the same as that of the proton and it was shown to follow Fermi statistics. It is also known that the neutron has got a magnetic moment because deuteron which is the nucleus of the heavy isotope of hydrogen is a compound of the proton and the neutron but its magnetic moment is not equal to that of the proton, but is sensibly lower. Therefore, the neutron must have in this combination a magnetic moment which is opposite to that of the proton. In other words it behaves like an antiproton. It has been estimated that the magnetic moment of the neutron must be of the order of one protonic unit. Recently attempts have been made to verify these suggestions. If a neutron has got a magnetic moment, it ought to be oriented when it passes through a magnetic field. Calculation shows that if a beam of neutron is allowed to pass through a magnetized piece of iron, the intense magnetic field of the particles produces this polarizing effect. If this beam of polarized neutron beams be allowed to pass through another piece of magnetized iron then the intensity of the beam would be different, according as the second iron piece is magnetised in the same direction or in the opposite direction to that of the first piece. This experiment which was conceived by Bloch has been recently carried out in the Cornell University by Hoffmann, Livingstone and Bethe and they have really established a differential effect. This proves that the neutron has got magnetic moment of the right order.

According to all uptodate conception, magnetism has been supposed to be due to motion of charged particles which might be either motion in orbit or a motion of the electrical particle round an axis (spin). But what is the moment of the neutron due to? It can be due to neither of the above causes as it has got no electrical charge. Time alone can solve this riddle.

M. N. S.

New types of Nuclear actions produced by Cosmic rays

The subjects of nuclear physics continues to yield more surprises. It has been felt by all investigators that the present laboratory technique is rather inefficient for producing reactions in the nucleus. For in order to score a hit on the nucleus, it is necessary to employ charged particles of such high energy that ordinary laboratory technique is not developed enough for producing them. The highest energy particles which have been so far produced are those due to Lawrence of California who, by means of his cyclotron, has produced particles having the enormous energy-value of ten million volts. But even these energies are rather insignificant compared to that of cosmic rays which are found to possess enormous values ranging from 100 million electron volts to about billion electron volts. Hence the cosmic rays produce reactions which, for a long time, cannot be emulated in the laboratory. But these particles are only God's gift and one has to set up the apparatus and wait patiently, go on taking records and find out from examinations of these records whether any new type of reaction is being produced. Already as a result of such investigations we have been in possession of the positron which is the unit of positive electricity having the same ratio of charge to mass as the familiar electron. The positron is produced by the cosmic rays hitting the nucleus. Recently C. D. Anderson has reported other types of nuclear reaction produced by cosmic rays. He found that in many cases *protons* are ejected from the nuclei. In other cases they appear to produce some kind of γ radiation, which falling on the nucleus ejects only positrons and the nucleus is supposed to be completely broken into neutral particles and charged positrons. Probably there are more surprises in store in this interesting field of investigation.

M. N. S.

Radio-active Potassium

When radioactivity was first discovered it was thought that this phenomenon was entirely confined to *heavy* atoms. It was supposed that the heavy atom was somehow unstable and spontaneously broke into pieces. In 1905, however J. J. Thomson showed that even some light elements show the phenomenon of radioactivity. He found that potassium and rubedium emit small amount of β- particles and that they had definite lives like other heavy radioactive bodies. The recent discovery of artificial radioactivity has shown that even the nuclei of light elements can be made radioactive by special treatment. But the old puzzle has not yet been solved. Why a naturally-occurring element like potassium should be radioactive! Some years ago Aston discovered that ordinary potassium atom consists of two isotopes one having the mass 39, the other 41. It was supposed that the radio-activity of potassium was due to the heavier and rarer nucleus, number 41. But experiments to prove this hypothesis were not successful. Just a year ago Nier showed that potassium contains an extremely rare isotope (1: 10,000) having the weight of 40. Smythe and Hemmendinger has now shown (*Phys. Rev. 51,* 178, 1937) that this very rare isotope of potassium is responsible for all the activity of ordinary potassium. This discovery raises interesting speculations in view of the recent work on the stability of atomic nuclei.

M. N. S.

On the identity of the idophenol reducing substances in brain and tumour tissues

Although the Tillmans-Harris technique of estimating ascorbic acid by titration against 2 : 6-dichlorophenol indophenol has been extensively used, doubts have periodically been raised regarding the specificity of the technique for ascorbic acid. Brain tissues and tumour tissues were, for instance, suspected to contain indophenol reducing substances other than vitamin C. More recent researches have indicated the unreliability of the evidence on which such suspicions were based. Thus Young (*Biochem. J., 30,* 1883, 1936) has found from biological studies as well as from studies of the absorption spectra that non-specific indophenol reducing substances do not appear to be present in brain extracts. Similar observations on tumour tissue have been made by Woodward *et al* (*J. Biol. Chem, 114,* 74, 1936) and Kellie and Zilva (*Biochem. J., 30,* 1216, 1936). These developments are important considering that there has been sometimes an undue suspicion about the reliability of the titrimetric method for the estimation of vitamin C, though, doubtless, whenever possible, titrimetric results should be clecked by other methods.

B. C. G.

University and Academy News

National Academy of Sciences, India

An Ordinary General Meeting of the National Institute of Sciences of India was held on the 25th March 1937 in the Physics Lecture Theatre, Allahabad University, Allahabad.

Following papers were read :-

1. M. N. Saha and R. N. Rai : Propagation of Radio Waves through the Ionosphere.
2. G. R. Toshniwal, B. D. Pant and R. R. Bajpai : On the Radio studies of the Upper Atmosphere at Allahabad.
3. R. N. Misra and S. Dutt : Chemical Examination of *Cleome Pentaphylla* Linn. Part II.-Constitution of the Oil from the Seeds.

National Institute of Sciences of India

A monthly meeting of the National Academy of Sciences, India, was held on 2nd March 1937 in the Lecture Theatre, Chemistry Department, Lucknow University. Dr. Birbal Sahni, D. Sc., Sc. D., F. G. S., F. R. S., President of the Academy was in the Chair. The following members of the Academy, among others, attended and took part in the discussion of the papers presented. Vice-Presidents—Prof. D. R. Bhattacharya, Prof. P. S. Mac Mahon, Foreign Secretary Prof. M. N. Saha, General Secretary Dr. S. M. Sane, Prof. N. R. Dhar, Prof. K. N. Bahl, Dr. Shri Ranjan, Dr. Lakshmi Narayan, Dr. A. C. Chatterji, Dr. K. N. Mathur, Dr. S. N. Das Gupta, Prof. W. Burridge and Dr. Gorakh Prasad.

The undermentined papers, of which brief summaries are given, were read :-

1. "Nitrogen fixation and azotobacter count on the application of carbohydrates and other energy materials to the Soil" by Prof. N. R. Dhar & Mr E. V. Seshacharyulu. In this paper the effect of sunlight on nitrogen fixation and azotobacter count on the appllication of sugars to the soil has been studied. Various sugars were tried to study the nitrogen fixation. Sugars in definite proportions were added to a known quantity of soil in basins and one set of basins was exposed to sunlight while another was kept in dark to exclude light, and at regular intervals nitrogen estimations and Azotobacter count were made. In all the experiments there is greater nitrogen fixation in the soil exposed to sunlight than in the soil kept in dark while the azotobacter numbers are more in the latter than in the former. When calculated per gram of carbon oxidized the nitrogen fixed is invariably greater in the exposed soils than in the dark ones. This clearly indicates that light plays a definite role in the soil processes like nitrogen fixation just as in the photosynthesis in plants.

2. "Changes in Soil nitrogen after the addition of fresh cowdung to Soil", by Mr S. K. Mukerji. Fresh cowdung has been showm to fix atmospheric nitrogen in dishes, in fields and in sterile vessels exposed to sunlight. The amount of nitrogen fixed as well as the amount of nitrogen fixed per gram of carbon oxidized is greater in light than in the dark. Molasses seems to stimulate the oxidation of cowdung in the soil, and increases the total amount of nitrogen fixed. Under the conditions of these experiments no white ants were seen to develop in the soil after the treatment with cowdung.

3. "The Alimentary canal of Coccinella septempunctata", by Mr S. Pradhan. During the course of his work on herbivorous and carnivorous Coccinellids, Mr. Pradhan has studied both types of these beetles and has made interesting observations. In the carnivorous lady - bird beetle, he has specially studied the problem of the reassociation of the excretory malpighian tubules with the high-gut, and has come to the conclusion that this reassociation is not meant for the discharge of excretory

material into the hind-gut, as has been believed by previous authors like Landis, but that the reassociated tubles act as a filter for eliminating waste nitrogenous material contained in the liquid which is mechanically pressed out of the hind-gut into body-cavity.

4. "Fossil plants from the Deccan Intertrappean beds at Mohgaon Kalan (C. P.) with a note on the *geological position of the plant bearing beds*", by Prof. Birbal Sahni, and Mr K. P. Rode. The affinities of the fossil flora of the Deccan Intertrappean beds strongly support the view, recently revived by Professor Sahni, that the earliest volcanic lavas (traps) of the Deccan were poured out in the Eocene period, that is soon after the dawn of the Tertiary era. This view was held by the pioneer geologists a hundred years ago, but during the last *seventy years, as the result of work done by the* Geological Survey of India, the opinion has grown that the earliest traps were older, and of Cretaceous age. This official view of the Survey, although based only upon indirect evidence, has been accepted by geologists all over the world ; but it is opposed to the direct evidence of the fossil plants which have decided Tertiary affinities.

In the first part of this paper Professor Sahni shows that the fossil flora of Moghaon Kalan near Chhindwara, originally discovered by Mr. Rode, has Tertiary affinities, like the flora of the rest of the Deccan Intertrappean series. In the second part Mr. Rode describes the geology of the area and shows that the fossiliferous beds really belong to the basal part of the series.

This latter fact is important, because if the basal part of the series is of Tertiary age, then there can be no ground whatever for classifying the higher strata as Cretaceous.

The value of fossil plants as an index of geological age is now being increasingly recognized in India, where the ages of some of the most important rock systems, containing coal, oil, salt and other mineral products, have been elucidated by a study of their plant fossils.

Calcutta Geographical Society

The 3rd Annual General Meeting of the Calcutta Geographical Society was held in the Geology Department, Presidency College. A large number of distinguished ladies and gentlemen besides the member attended the social gathering. Dr. A. M. Heron, Director, Geological Survey of India, delivered the Presidential Address on "Where Burma meets Siam" illustrated with many beautiful slides. The Council for the year 1936-37 was constituted as follows :—

COUNCIL FOR THE YEAR 1936-37

President—Dr A M. Heron, Director, Geological Survey of India. ***Vice-Presidents***—Dr D. N. Wadia, M. A., Geologist, Geological Survey of India. Mr W. D. West, Geologist, Geological Survey of India. Mr A. F. M. Abdul Ali, Keeper of Imperial Records, and Secretary, Indian Museum. ***Jt. Secretaries***—Mr D. P. Ghose, lecturer, Calcutta University, and curator, Ashutosh Museum of Arts. Mr S. P. Chatterjee, lecturer in Geography, Teacher's Training department, Calcutta University. ***Treasurer***—Mr B. N. Maitra, Professor, Presidency College, Calcutta. ***Librarion***—Dr M. Chatterjee, Professor, Presidency College. ***Members***—Mr P. K. Sammaddar, Brahmo Boys School. Mr K. C. Chowdhury, Ashutosh College, Calcutta. Mr N. C. Bhattacharya, Scottish Church College, Calcutta. Dr H.C. Roy, Calcutta. Mr S. C. Sarkar, Presidency College. Mr N. N. Chatterjee, Calcutta University. Mr U. P. Mukherjee, Advocate, High Court. Mr A. N. Basu, Calcutta University. Miss Rani Ghose, Gokhale Memorial School. Mr B. Nag, Teacher, Rani Bhabani School. Mr J. K. Das Teacher, Ripon Collegiate School.

Co-opted :—Dr S. C. Chatterji, Ranchi Rai-Shahib Haridas Goswami Asansol. Mr Sasadhar Banerjee, Midnapur and Mr. Lalit Nohan Ghose, Cuttack.

We give below a summary of the lecture "Where Burma meets Siam" delivered by Dr A. M. Heron, Director, Geological Survey of India, at the 3rd Annual Meeting of the Calcutta Geographical Society.

The lecturer described the geography of the two most southerly districts of Burma, Tavoy and Mergui, which are bounded by Siam, and said that before the British occupation in 1826, they were, for over a century, a battle ground between Burma and Siam. From the fourteenth century, Mergui belonged to Siam, and as the isthmus between the Bay of Bengal and the Gulf of Siam was narrow there, it was the gateway of the most direct trade route from India and Arabia to the Far East. With a wet climate and constant warmth these districts support luxuriant vegetation, as yet hardly exploited, and tropical fruits, such as the durian, the pineapple and the mangosteen are abundant and excellent. The cultivation of rice is the principal agricultural avocation but the fisheries provide an important export trade in dried and salted fish and prawns, with such curious side-lines as mother-of-pearl, beche-de-mer, shark's fins, edible birds'nests and turtle-eggs. The industries of European introduction are tin and wolfram mining and rubber planting. The population is most cosmopolitan, Burman, Malay, Siamese, Karen, as permanent inhabitants with Chinese, Madrasis, Moplahs, Punjabis and Gurkhas as colonists. The most interesting race is the Salons, or Sea-gypsies of the Mergui Archipelago. They number about 6,000 and live entirely in their sailing about from island to island, diving for green snail shell and beche-de-mer. They live almost exclusively on shell fish, and what other fish they can appear, such as the giant ray.

Botanical Society of Bengal

The first Annual General Meeting of the Botanical Society of Bengal was held on the 4th March 1937 in the Botanical Laboratory of the Calcutta University. In the unavoidable absence of the President, Prof. S. P. Agharkar, a Vice-President of the Society took the Chair.

H. E. the Governor of Bengal in a message to the Society stated that he trusts that the interest which the Society has already been able to arouse may lead in the future to developments of value and importance.

The Council's report for the year which was read by the Hony. Secretary showed all round progress in the work of the society. At the close of the session the number of ordinary members on the rolls was 65. And the secretaries are hoping to be able to enroll a much larger number of the teachers of Botany and others as members of the Society during the current year. The society held 9 ordinary general meetings in which 10 original papers were read and discussed. Some of them have already been published in scientific journals. The society also arranged for popular lectures and excursions. A programme of local excursions has been drawn up for the coming year, during which it is proposed to study the local flora and collect materials for the compilation of a flora of Calcutta and its suburbs.

A resolution was passed urging the Government of Bengal to take early steps in revising and publishing Sir David Prain's *Bengal Plants*. The book is now out of print and is absolutely necessary for all interested in the flora of the Province.

The following were duly elected as Office-bearers for the year 1937 :—*President*—Prof. S. C. Mahalanobis, *Vice-Presidents*—Prof. S. C. Benerji, Prof. S. P. Agharkar, Mr C. C Calder, and Mr W. Mieklejohn I.F.S. *Treasurer*—Prof. G. P. Majumdar, *Councillors*—Mr S. N. Bal, Mr I. Benerjee, Mr S. N. Banerji, Mr P. K. Bose, Mr A. Das Gupta Mr A. C. Datta, Mr N. N. Mitra, Mr N. N Sarkar and Mr A. Sen. *Hony Secretaries*—Dr J. C. Sen Gupta and Mr A. K. Ghose.

A Botanical Exhibition and Conversazionne was organized on the occasion which attracted a large number of students and the public. Prof. S. P. Agharkar delivered an illustrated popular lecture on the flora of Nepal.

Letters to the Editor

Vitamin C in Chewing Betel Leaf (*Piper Betle*)

Betel leaf is a fixture all over India on all ceremonial occasions. Further *Pan* and its juice are prescribed in Ayurvedic practice. Chewing of betel leaf is a daily practice in India.

In connection with the investigation on the vitamin contents of certain Indian vegetable foodstuffs, undertaken in this laboratory during the last few years, interesting results were obtained with chewing betel leaf, as the result of a systematic examination of the different varieties. A synopsis of the results is given below :—

	mg. of ascorbic acid per gram of leaf	mg. of ascorbic acid per gram of stem	Average free reducing sugar
	I *Karpuri Pan*		
Sample 1	0.225	0.100	1.46%
Sample 2	0.109	0.080	
Sample 3	0.170	0.100	
	II *Mitha Pan*		
Sample 1	0.120	0.080	
Sample 2	0.108	0.070	
Sample 3	0.112	0.080	0.89%
Sample 4	0.130	0.100	
	III *Sachi Pan*		
Sample 1	0.090	0.060	
Sample 2	0.087	0.050	0.80%
Sample 3	0.070	0.040	
	IV *Gach Pan* Grown in the Bose Institute		
Sample 1	0.070	0.040	
Sample 2	0.080	0.040	
Sample 3	0.090	0.040	†
Sample 4	0.158	0.050	This sample was from plants grown at Falta experimental station of the Institute. The leaves were rather young.
	V *Ordinary (Bangla) Pan*		
Sample 1	0.043	0.022	
Sample 2	0.047	0.023	0.38%
Sample 3	0.056	0.026	

Each sample represents the average value from one dozen leaves. The extraction was done by sand grinding and trichloroacetic acid solutions; the estimation was done by the usual titrimetric method of assay. The titration value of the extract did not increase after boiling. In the above it is found that the vitamin C content of the leaves runs parallel with the free reducing sugar content, and that the leaves are very much richer than the stems.

Bose Research Institute Laboratory, Calcutta.
24. 2. 37

H. N. Banerjee
A. K. Pain

The Magneto-ionic Formula

I have read with great interest the letter of Dr Toshniwal[1] and also the communication of Mr Bhar[2] along with the introductory letter of Dr Mitra.[3] It appears to me that Mr Bhar has laid too much stress on the form of the Appleton-Hartree formula and on the quantity under the radical, and that in doing so he has forgotten the original quadratic equation obtained by generalising the treatment of Lorentz. The equation in the standard form ($ax^2+bx+c=o$) is given by

$$(1+a+i\beta)\left(\frac{1}{c^2q^2-1}\right)^2-\left\{2(a+i\beta)(1+a+i\beta)-\gamma_T^2\right\}\left(\frac{1}{c^2q^2-1}\right)+(a+i\beta)^2(1+a+i\beta)-(a+i\beta)\gamma_T^2-(1+a+i\beta)\gamma_L^2=0$$

(The notations carry their usual significance.)

The solution of the above equation gives the value of c^2q^2 as

$$c^2q^2=1+\frac{1}{(a+i\beta)-\dfrac{\gamma_T^2/2}{(1+a+i\beta)}\pm\dfrac{1}{2(1+a+i\beta)}\times\sqrt{\gamma_T^4+4\gamma_L^2\,(1+a+i\beta)^2}}$$

It is now obvious that the quantity of which the absolute value is to be taken is $\left[\gamma_T^4+4\gamma_L^2\,(1+a+i\beta)^2\right]$ and not $\left[\left(\frac{\gamma_T^2/2}{1+a+i\beta}\right)^2+\gamma_L^2\right]$ as stressed by Mr Bhar.

It is rather unfortunate that in Dr. Toshniwal's communication the dispersion equation appears in a form which has given rise to some confusion.

If we agree to call the ray given by $1+\alpha=0$ as the ordinary ray, it is apparent from the above equation that the positive sign before the radical always gives the condition of reflection for the ordinary ray, irrespective of the sign of $(1+\alpha)$, thus we see the ambiguity of sign stressed by Mr Bhar does not come in. It is from this anology that Dr Toshniwal has, even in the quasi-longitudinal case, called the ray corresponding to the positive sign as the ordinary although its condition of reflection is influenced by the earth's magnetic field.

The two rays in the case of quasi-longitudinal propagation are polarized in opposite senses and hence it is not possible to agree with Prof. Mitra in calling the two rays as extraordinary.

It may also be pointed out that what Mr Bhar calls Dr Toshniwal's exclusive convention is really the only logical convention which has been widely used.

Physical Laboratory,
University of Allahabad,
Allahabad, 19.2.37.

R. R. Bajpai

1. Toshniwal— SCIENCE & CULTURE *2*, 277, 1936.
2. Bhar—*Ibid*, *2*, 322, 1936.
3. Mitra—*Ibid*, *2*, 322, 1936.

The Magneto-ionic Formula

In trying to support Dr Toshniwal[1], Mr Bajpai comments that in my letter[2] the original quadratic equation obtained by generalizing the treatment of Lorentz has been lost sight of and that too much stress has been laid on the form of the Appleton-Hartree formula and on the quantity under the radical.

It seems that Mr Bajpai has forgotten the original equation, *viz.*,

$$\left[\frac{1}{c^2q^2-1}-(\alpha+i\beta)\right]\times\left[\frac{1}{c^2q^2-1}-(\alpha+i\beta)+\frac{\gamma_T{}^2}{1+\alpha+i\beta}\right]=\gamma_L{}^2 \qquad \ldots(1)$$

(Appleton, *J.I.E.E.*, p. 647, vol. 71, 1932), from which the magneto-ionic formula is deduced. This equation may be transformed into either of the two forms

$$\left[\frac{1}{c^2q^2-1}-(\alpha+i\beta)\right]^2+\frac{\gamma_T{}^2}{1+\alpha+i\beta}\left[\frac{1}{c^2q^2-1}-(\alpha+i\beta)\right]-\gamma_L{}^2=0 \quad \ldots(2\cdot1)$$

$$\text{and}\;(1+\alpha+i\beta)\left[\frac{1}{c^2q^2-1}-(\alpha+i\beta)\right]^2+\gamma_T{}^2\left[\frac{1}{c^2q^2-1}-(\alpha+i\beta)\right]-\gamma_L{}^2(1+\alpha+i\beta)=0 \quad \ldots(2\cdot2)$$

Both of these are of the standard form $ax^2+bx+c=0$ and are quadratics in $\left[\frac{1}{c^2q^2-1}-(\alpha+i\beta)\right]$

Equation (2.1) gives

$$c^2q^2=1+\frac{1}{(\alpha+i\beta)-\frac{\gamma_T{}^2}{2(1+\alpha+i\beta)}\pm\sqrt{\frac{\gamma_T{}^4}{4(1+\alpha+i\beta)^2}+\gamma_L^2}} \quad \ldots(3.1)$$

and equation (2·2) gives

$$c^2q^2=1+\frac{1}{(\alpha+i\beta)-\frac{\gamma_T{}^2}{2(1+\alpha+i\beta)}\pm\frac{1}{2(1+\alpha+i\beta)}\times\sqrt{\gamma_T{}^4+4\gamma_L{}^2(1+\alpha+i\beta)^2}} \quad \ldots(3\cdot2)$$

Mr Bajpai, if he had cared to read carefully my communication would have seen that I have considered both these forms of quadratic equations, the first one in section I and the second one in section II. It is explicitly stated there that the source of confusion and ambiguity disappears if the quadratic equation is written in the form of equation (5d) of my note. The magneto-ionic formula derived from this equation is given in equation (6) of that note. This equation is the same as equation (3.2) above and is of the form of the magneto-ionic formula of Mr Bajpai (only β has been put equal to zero). Mr Bajpai has merely repeated what I have already said.

Equation (3.1) was discussed in more detail only to point out the origin of ambiguity in the conclusions arrived at by Dr Toshniwal by starting with this form.

Regarding the nomenclature of ordinary and extraordinary in the quasi-longitudinal case, Mr Bajpai seems to be inconsistent with his own statements. At one time he defines the ordinary ray as a ray whose reflection condition is given by $1+\alpha=0$ but at the very next moment he apparently discards this definition and calls a ray whose reflection condition is *not* given by $1+\alpha$ equal to zero but is given by $1+\alpha=+\gamma$ as ordinary. He agrees (with everybody else) that the fundamental characteristic of the ordinary ray is that its condition of reflction is unaffected by the magnetic field and is given by $1+a=0$. This being agreed upon, the state of the polarization of the ray whether it is right-handed or left-handed is immaterial and irrelevant to the point under discussion. I am not aware if it is stated anywhere that the ordinary ray is called as such because it is polarized in a particular way.

Since in the quasi-longitudinal case the reflection condition of one of the split components is given by $1+a=-\gamma$ and that of the other by $1+a=+\gamma$, neither of these can be called ordinary.

Wireless Laboratory, **J. N. Bhar.**
University College of Science,
92, Upper Circular Road, Calcutta.
17. 3. 1937.

1. Toshniwal, SCIENCE & CULTURE, *2*, 277, 1936.
2. Bhar, *Ibid*, 2, 322, 1937.

Anthropological Expedition in West China

An Anthropological expedition was carried on till August 1936, into the Ch'wan Miao country in the south and south-east of the province of Szechwan, West China. The expedition consisted of Dr D. C. Graham, Dr R. G. Agnew, and Dr W. R. Morse. They were accompanied by five Chinese assistants.

Dr Graham found many stone articles and specimens. Dr Agnew studied them and translated their folk-songs.

This was the tenth expedition into the aboriginal tribes' country on the Szechwan-Tchetan-Kweicheo-yunnan borderland. Dr Morse has taken 8,046 anthropological measurements on Chinese, Tibetan, C'hiang, GiaRong, Noso (Lolo), Shi (Hsi) Fan, Bolotsi, Miao (Ta Heva), Miao (Ch'wan) and Chungchia.

Minendra Nath Basu.

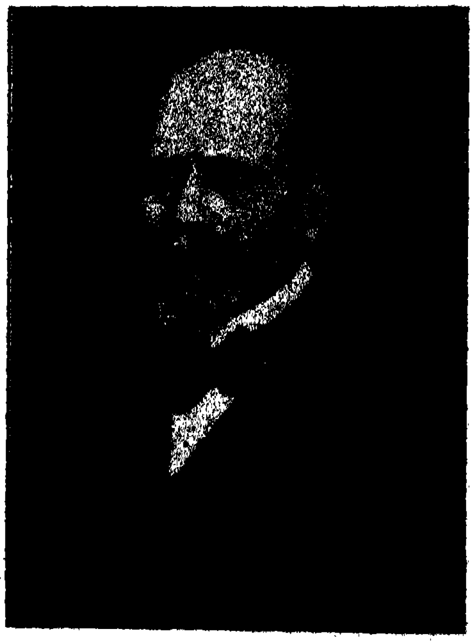
Obituary

Professor Moritz Winternitz

On January 9, 1937, passed away the great Sanskritist, Dr Moritz Winternitz, Professor of Indology and Ethnology at the German University of Prague in Czechoslovakia. He was born on the 23rd of December, 1863, of Jewish parentage, in a small village in Austria, and was educated at the University of Vienna, where the great indologist, Georg Bühler, was his *guru.*

Dr Winternitz made a mark as an industrious scholar and a good Sanskritist quite early in his career. When Max Müller was engaged in preparing the second edition of the *Rigveda-Samhitā*, young Winternitz was engaged as his assistant. He prepared a *Catalogue of South Indian Sanskrit Manuscripts belonging to the Royal Asiatic Society*, which was published in 1902, and worked at a supplement to Aufrecht's catalogue of Sanskrit manuscripts in the Bodleian Library at Oxford, which was completed by A. B. Keith and published as Volume II of the *Catalogues* in 1905. The preparation of these two catalogues gave him a very wide knowledge of Sanskrit literature and equipped him for his *magnum opus, Die Geschichte der indischen Literatur* (History of Indian Literature).

He acquired from Bühler an interest in the life of the Indians during the later Vedic age. He brought out in 1887 from Vienna an edition of the *Apastamba Grhya Sūtra* and communicated to the Vienna Academy in 1890 a valuable paper (*Das altindische Hochzeitsrituell*) on the marriage ritual according to the *Apastamba Grhya Sūtra* and other texts and compared with the marriage customs of other Indo-European peoples (published in the Proceedings of the Academy in 1892). He communicated to the International folk-lore Congress of 1891 a similar paper in English, which was published in its Transactions next year. His interest in the Sūtra literature continued for a long time and he wrote other papers on these texts and brought out in 1897 an edition of the *Mantrapaṭha* (*mantras* used in the Gṛhya rituals) of the Apastambins (Clarendon Press, Oxford). We may mention here his contribution on the position of women in Brahmanical literature (*Die frau in den indischen Religionen*, Bd. I : *Brahmanismus*) in the *Archiv fuer Frauenkunde*, III, which was reprinted separately in Leipzig in 1920. A series of papers that he contributed to the supplement to the *Allgemeinen zeitung* of Munich in 1903, under the title "*Was wissen wir von den Indogermanen ?*", carefully analysed the evidence about Indo-European *Urkultur* (Primitive culture) and won great praise from specialists in the subject like Otto Schrader of Breslau. His wide reading and comparative interest are further evident from a paper on the Flood-Story among ancient nations and primitive peoples, published in Vol. XXXI of the *Mitteilungen der anthropologische Gesellschaft* of Vienna (1901).



Professor Moritz Winternitz

The C. F. Amelangs Verlag of Leipzig asked him to contribute a volume on the history of Indian literature in their well-known series *Die Literaturen des Ostens*, in which appeared Brockelman's volume on Arabic literature. Professor Winternitz agreed but found in course of his work that the subject could not be completed in one volume. His first volume appeared in two parts, part 1 dealing with Vedic literature (published in 1905) and part 2 with the great epics and the Purāṇas (1908). At that time he was expecting to finish the remaining literature in one more volume, but the second volume, again in two parts, contained only Buddhist literature (1913) and Jaina literature (1920). A third volume had to be published in 1922, containing the remaining literature, including philosophy and technical subjects, with an appendix on the vernacular literatures of modern India which showed that his interest was not confined to only the ancient literature of India. He published a paper on the poetry and the philosophy of religion of our poet, Rabindranath Tagore, in *Die Geisteswissenschaften*, volume I. when Professor Winternitz came to India at the invitation of Rabindranath, in whose Visvabharati he stayed as visiting professor during 1922-23, several persons expressed regret that his great History of Indian Literature was in German and was, therefore, inaccessible to most Indian readers. At the suggestion of Professor I. J. S. Taraporewala, the Calcutta University undertook to publish an English translation of this great work. The first volume appeared in 1927 and the second in 1933. The English edition is by no means a mere rendering of the German original but is a thoroughly revised edition and contains a large amount of additional material. One of the important additions is a section in volume I on the literature of the *Tantras*, a subject very much neglected by European Sanskritists, on which Professor Winternitz had published a paper in the *Ostasiatische Zeitschrift*, vol IV (1916). It is very much to be regretted that the Professor did not live to see the publication of the third volume of the translation, whose revision cannot be now expected to be as thorough as the two volumes published already. His *History of Indian Literature* is a great work which cannot be superseded in our life-time. It is not only comprehensive and up-to-date to the years of publication, but is written from essentially human point of view, showing deep sympathy with the Indian mind.

While in India, Professor Winternitz delivered lectures at a number of places. His Readership Lectures delivered in the University of Calcutta in 1923 on problems in the history of Sanskrit literature were published in the *Calcutta Review* and later on in book form in 1925 under the title "*Some Problems of Indian Literature*". He published a large number of papers on different branches of Sanskrit and Sanskritic literatures in various journals in Europe and, latterly, in India too. His contribution to the problem of the history of the dialogue hymns of the *Rigveda-saṃhitā* is of considerable importance. Whereas Oldenberg supposed that they are the relics of old *ākhyānas* or stories, in which the speeches were in verse, which have been preserved, and the narrations in variable prose, now lost, and Levi, Hertel and Schroeder believed that they were a kind of drama, Winternitz opined that we have to see in them ancient ballads as in later literature in India (*e.g.* in the *Mahābharata*) and in the literatures of many other peoples.

Professor Winternitz took great interest in the *Mahābhārata* and its text. He published in the *Indian Antiquary*, Vol. XXVII, a paper in the South Indian Manuscripts of the epic and a number of notes on the *Mahābhārata* in the *Journal of the Royal Asiatic Society* and elsewhere. The Bhandarkar Oriental Research Institute of Poona placed him on the Editorial Board of the great edition of the *Mahābhārata* that they are bringing out. He edited along with his pupil, Professor Otto Stein, the *Indologica Pragensia*, a series of papers on Indology, and was on the Editorial Board of the *Archiv Orientální* of Prague.

Professor Winternitz was deeply interested in the religious life of Ancient India. He compiled the Index Volume of the Sacred Books of the East published by the Clarendon Press of Oxford, of which the majority of volumes are devoted to Indian religions. This Index is a concise dictionary of

Eastern religions and was published as volume 50 of the Series in 1910. On Buddhism Winternitz contributed a very large number of papers. He translated for A. Bertholet's *Religionsgeschichtliches Lesebuch* a representative selection from Buddhist scriptures, of which the first edition appeared in 1908, and the second in 1929 ("Early Buddhism") and 1930 ("Mahāyāna Buddhism"). He contributed to Hastings' *Encyclopaedia of Religion and Ethics* an article on Jātakas. One of his latest papers on Buddhism was "Self and Non-Self in Early Buddhism", written for the *Ganganatha Jha Commemoration Volume*, now in course of publication, which he would not unfortunately see published in his life-time.

The Professor was very much respected by Indian scholars, as he was by western scholars, and he was asked to contribute papers to a number of other commemoration volumes recently published in India. A commemoration volume (*Festschrift Moritz Winternitz*), containing a large number of papers contributed by his pupils, friends and admirers, eastern and western, was presented to him on December 23, 1933, when he completed his seventieth year. The American Oriental Society made him an Honorary Member in 1923 and the Royal Asiatic Society of Great Britain and Ireland in 1934. He received similar distinctions from other learned bodies also. There was a proposal to invite him to preside over the *Ninth All-India Oriental Conference* to be held in Travancore in December 1937.

During the short time that Professor Winternitz was at Sāntiniketan, he gathered round him a number of very enthusiastic students like Dr C. Kunhan Raja (now in the Madras University), Dr Haradatta Sharma (now in the Hindu College, Delhi) and Mr P. Anujan Achan (now in the State Museum at Trichur in Cochin). One of the students, a lady, told me what a keen teacher and a lover of accuracy he was. The Professor was very kind to his students and to all scholars with whom he came in contact in any way.

Professor Winternitz cherished a wish to come to India once again but the death of his wife gave him a great shock and the idea had to be given up. He did not survive her long. The whole life of the Professor was one of unostentatious devotion to work. He was a great lover of India and resembled Indian Pandits in his simplicity. It was characteristic of him that his last wish was to be cremated quietly. He leaves behind four sons and one daughter and one sister. His children are all doctors and even so are his daughter-in-law. One of the sons is a Professor.

Indology has suffered an irreparable loss at the demise of Professor Moritz Winternitz. May his soul rest in peace!

K. C.

On p. 480 of the present issue in the author's designation line *please read* "Indian Civil Service, Kurseong" *in place of* "Indian Civil Service, Shillong".

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Problems of Industrial Development in India

It is, of course, generally recognized that the industrial progress that was achieved by the Western countries during the last two centuries was stimulated and conditioned largely by their economic needs. Pressure of population and shortage of food-stuffs at home were responsible, for instance, to a large extent for the development of international trade. The need of quicker and safer transport across land and sea was urgent and this contributed consciously or unconsciously to a large part of the scientific discoveries and inventions and their industrial applications that we see today. The scientific movement was thus set afoot and then it proceeded at its own momentum, often irrespective of its immediate applications. The courses of scientific and industrial progress have, however, throughout mutually influenced each other. Even "pure" science, it is generally admitted now, subserves directly or indirectly human and social needs and the expression "science for science's sake" like the sister adage "art for art's sake" is fast passing out of the vocabulary of those who have looked into the genesis, history, and future of both science and art. Not that scientific research cannot or should not be carried out with the interest centred chiefly in itself but it is fallacious to think that, for this reason, it is objectively dislodged from the social framework in which the work is proceeding. As is known, even the recent developments in theoretical physics have had their repercussions on our philosophical and social concepts.

The scientific and industrial movement in India began recently. For a long period her economic self-sufficiency and political causes retarded scientific and industrial development. The increase in population, the fragmentation of holdings, and the terrific pressure on land for livelihood have brought this country to a stage of semi-starvation. The want of balance between industry and agriculture is the paramount cause of India's appalling poverty and it is absolutely clear that in any scheme of economic reconstruction the question of industrial development occupies the pivotal position. While, therefore, every support must be given to recent activities in India concerning the promotion of agriculture and animal husbandry, the problem of industries should no longer be allowed to remain in the cold shade of neglect.

The reasons are well known how and why India's industrial progress was held back and even what little home industry she had gradually perished. The last war, however, brought home to the Governments in Great Britain and in India that India's tragic dependence on foreign imports for even essential industrial commodities was a peril even to the Imperial Government. This led to a slight reorientation of State policy during the post-war period and a cautious policy of protecting Indian industry was followed. But the policy, if it is to be effective, must be vigorous. Presiding over the annual meeting of the Federation of Indian Chambers of Commerce and of Industry held on the 7th April at Delhi, Mr D. P. Khaitan thus observed :

> "I would urge that the Government of India should modify their present luke-warm attitude towards industrialization and should initiate a bold policy of industrialization for the benefit of the country. Industrialization demands adequate protection, and the provinces which have hitherto least industrialized themselves need protection the most. It is necessary that in addition to protective tariffs there should be cheap transport facilities, cheap money conditions, and an ample supply of funds. We find that even the prevalence of cheap money conditions in the market does not ensure a plentiful supply of funds for industrial finance.
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> "The currency policy of the Government of India is determined by conceptions about the rate of exchange, which I can only characterize as antinational. The Government of India, I regret to say, have no definite or positive industrial policy. Thus even the present halting policy of protection adopted by Government during the last 12 years has no small achievement to its credit. The industries which developed during the last ten years, although they have had restricted scope for expansion under the present policy of discriminating protection, have been contributing annually, on a conservative basis, about Rs 100 crores to the national wealth of India ....There must be a closer parallelism between the expansion of agricultural produce on the one hand and the development of means for its consumption on the other.......Industrialization of India is absolutely essential in order to lessen the pressure of population on land, to provide alternative sources of employment in order to absorb the surplus population, and to diversify economic pursuits".

We whole-heartedly endorse the above remarks of Mr Khaitan, although we are constrained to say that Indian industrialists, protected by tariffs, have not usually given a square deal to their workers, both intellectual and manual, and that any policy of protection must give proper importance to consumers' interests and ensure that the profits earned are distributed as equitably as is possible under present conditions among the producers of wealth. Our industrialists, it is generally felt, have not always taken advantage of the period of protection to increase the scientific efficiency of their industries and to acquire the capacity to compete subsequently in the open market. They, as a class, have still hardly realized the importance of scientific research for industries in these days of hard competition and often give the impression of looking to the present to the neglect of the future. It does not seem to be sufficiently appreciated that industry in the twentieth century either goes up or goes down but does not remain stationary, and that it is impossible to go forward without harnessing the intellectual resources available in the country. But whatever be the defects of Indian industry awaiting remedy, it is clear that the industrial progress of India is practically impossible without a wise and bold policy of protection, operating solely in India's interest. We do not in principle favour the policy of economic nationalism, which is retarding the restoration of sound international economic relations and is increasing tension and war danger, but we believe that the reality must be faced and that, so long as even highly industrialized countries resort to high tariffs, adequate protection must be afforded in India where industry is still in an infantile condition.

In this connexion a word may be said about the question of cottage industries. Of late both the central and provincial Governments seem to have given some attention to this question in connexion with rural uplift work. The revival and establishment of cottage industries have also formed part of the programme of several non-official organizations. The matter has, therefore, been fairly prominent before the public eye. There is the possibility that some improvement may be made in the economic condition of the people by such means. But nobody who has thought about the matter will pin his faith on such activities for the industrialization of India. Real industrial progress of a nation connotes organized industrial activity based on a sound well-thought-out policy, which considers among other things the available resources in the country both as raw materials and as sources of power, the needs of the home and outside markets, and the inter-relationships between industries. Comprehensive plans obviously require State patronage and support. Without sufficient confidence in this direction it is idle to expect the requisite capital to be invested in really largescale industries. There has been, nevertheless, some progress in this matter, but everybody will admit that the progress has been inordinately slow. The increase in population at the same time has been relatively rapid and India's need of agricultural and industrial products is far outstripping home production. Nevertheless, we feel that, if cottage industries are encouraged not in a sporadic manner but with the same efficiency of organization and sincerity of purpose as in Japan, they can be made to fill a real gap in our national economy. In Japan, although the production takes place in individual homesteads, there are highly efficient organizations for collecting the products, finishing them further if necessary, transporting them and finding their suitable markets. It is well known that without organized facilities by way of collection, distribution, and particularly transport (especially with reference to shipping) in all of which the State played and plays an important part, the Japanese cottage industries could not have held the position that they do today. In our country also this organizational question is of paramount importance. If we are to get all that we can out of cottage industries, immediate steps must be taken in this direction. It is good to see that the Industries Department of the Government of Bengal is going into this question of collection, transport, and marketing in connexion with the small coir industries that are developing in certain districts of Bengal. But the pace of progress, we are afraid, is very slow. The same method should be pursued without delay in connexion with the other cottage industries.

It would, however, be a pity if this question of cottage industries diverts our attention, as it sometimes tends to do, from the major problems of industrial development. Concerted action is necessary in this direction. Apart from questions of State policy, over which we cannot have effective control, it seems to us that the present unsatisfactory situation concerning industries can be remedied to a considerable extent by providing necessary contacts. As Professor M. L. Schroff points out in an article published elsewhere in this issue of SCIENCE & CULTURE, there is a great need in this country for co-operation between universities and industries like that which exists in the Western countries. This is shown by the fact that members of the university staff in those countries act as consulting scientists to industries, that numerous scholarships and large research grants are provided by industries for work at the university laboratories either for general or specific purposes, and that there is greater contact and a freer flow of workers between university laboratories and those run by industries. The Massachusetts Institute of Technology, for instance, has got a full-fledged department of industrial co-operation, whose main function is to stimulate and maintain such contacts. It has been recognized by the most successful industrialists of the Western countries that such co-operation has proved to be of the greatest good to industry. The co-operation between universities and industry, between pure science and applied science, has always been effective in Great Britain. Even so, it is interesting to observe that during the last five years there have been still greater efforts to promote this co-operation and it has been pointed out that the advantage of Germany industrially was primarily due to this cause. Sir Frank Smith is a Secretary of the Royal Society, the premier scientific body in Great Britain, and is also Secretary to the Department of Industrial and Scientific Research of the Government. This, we think, is symptomatic of the tendencies of the times. Pure and applied sciences are more than ever coming into collaboration for the good of the community. We plead, therefore, for greater co-operation between the scientific departments of our universities and the industrial organizations of the country.

A concrete step in the above direction would be to set up an "Industrial Development Bureau," as was suggested by Prof. B. C. Guha at a symposium on the teaching of applied chemistry, held at the Hyderabad session of the Indian Science Congress in January this year. That symposium, in which Dr H. K. Sen, Dr R. B. Forster, Dr K. G. Naik and many others took part, indicated that the teaching of applied chemistry at the universities should be so modified and conducted that the trained men could be more directly suitable to industry; but the paramount need that was felt was the absorption in industry of such trained young men as already exist. If there is hardly any co-operation and exchange of

(*Continued on* 577)

Recent Progress in Television and Ionospheric Research

Ram Ratan Bajpai and K. B. Mathur

[OUR readers are probably aware that Prof. S. K. Mitra, Ghose Professor of Physics in the University of Calcutta, recently returned to India after a year's tour in Europe and America. He visited most of the principal research centres on Television and Ionosphere, and studied the latest methods of research in these subjects. He recently visited Allahabad and on the request of Prof. M N. Saha gave a talk about his experiences to the senior students and research scholars of the University. The following account has been compiled from his talk by Mr Bajpai and Mr Mathur.

Editor, SCIENCE AND CULTURE]

Television

PROF. Mitra said that since he last visited Europe in 1921-23, television had made tremendous progress and was now a practical commercial proposition. Television programme had now definite entertainment value and, as such, was bound to become as popular as the radio for home entertainment in no distant future. The only drawback was the high cost of the tele-receivers—estimated to be about 60 to 100 guineas each; but, with the spread of the service and increase of demand, the price was sure to come down to a more reasonable level.

In describing the demonstration of television reception which he had witnessed, Prof. Mitra said that the most common type of home receiver utilized the cathode ray oscillograph for the televised image. The screen of the oscillograph had a diameter of about 40 cm. and an image of size 30 cm. by 23 cm. was thrown on it. The tube itself was mounted in a cabinet (size about 1·5 m. high and 50 cm by 50 cm.) inside which there were the receiving and synchronizing equipments for both the vision and the sound. When the receiver worked one had the impression of witnessing the projection of a talkie film. The smallness of the size of the image was rather a drawback. Though it was just large enough for indoor, drawing-room entertainment purposes, yet it left one with a feeling of fatigue and dissatisfaction, wishing that it were somewhat larger. The moving images which one saw on the screen was either that of some actual scene enacted in the studio or that of some film. Sometimes the intermediate film method was used in which the film was exposed to the enacted scenes or events, developed, fixed, dried, and immediately transmitted within a time ranging between 20 and 30 seconds. For all practical purposes, from the point of view of reception, this could be regarded as actual, simultaneous witnessing of the event or the enacted scene. There were some technical advantages in the so-called intermediate-film method.

Fundamental Processes in Television

Continuing Prof. Mitra said that in order to appreciate the recent progress in television it was necessary to understand the fundamental processes involved in the transmission of living scenes or cinema films and reception of the same. There were three stages in the process: (1) scanning of the scene, (2) electrical transmission of the scanned scene from one point to another, and (3) reconstruction of the picture at the receiving end.

By the process of scanning the scene was divided in a regular manner, generally in the form of horizontal parallel strips and converted into the light and shade value of every portion of each strip

—from left to right (say)—one strip succeeding another from top to bottom. The degree of definition of the picture was determined by the number of strips. 30 to 60 strips per picture meant low definition and 120 strips (or lines as they are usually called) and above high definition.

The methods of scanning could be broadly divided into two classes, one mechanical and the other electrical.

Scanning—Nipkow disc, spot-light scanning, Iconoscope and Electron-Camera

The simplest mechanical scanner consisted of a circular disc. Near the periphery of it there was a row of holes in staggered formation. An object of limited size (depending upon the distances between the holes) if viewed through such a disc, when the latter was in rapid rotation, would be scanned strip by strip. The disc was called Nipkow disc and the object or the scene to be scanned was required to be very strongly illuminated.

A variation of disc-scanning called spot-scanning was in more common use and did not require such strong illumination. In fact, the object or the scene to be scanned was usually in a darkened studio; an intense spot of light coming from a brilliant arc light and passing through the holes of the revolving disc rapidly swept over the entire object or scene to be televised strip by strip.

In the electrical method a beam of cathode rays was employed for the scanning purpose. The great advantage of such a beam was that it was practically without weight and hence could be deflected sideways or up and down in the quickest imaginable time. Two distinct forms of cathode ray tubes, both of American origin, had been developed for scanning purposé. One was known as the iconoscope and was due to Mr Zworykin of the Radio Corporation of America, and the other the electron-camera or the image-dissector due to Mr Farnsworth of Farnsworth Television Corporation of Philadelphia.

The iconoscope was a vacuum tube in which there was a surface having a mosaic structure consisting of tiny silver globules. Each of these was made photo-sensitive, so that it would eject electrons when light was allowed to fall upon it. This resulted in a charging up of the globules by an amount proportional to the intensity of the incident light. Now, the scene to be televised was focussed on the mosaic surface and, according to light and shade value of different portions of the picture, produced different degrees of charge on the different silver elements. For converting the optical or rather the electrically charged image of the scene to corresponding electric impulses for transmission from one point to another, a cathode-ray beam, produced inside the vacuum tube, swept over the entire image strip by strip from top to bottom. Each of the silver elements was made to release in turn the charge which was locked in the condenser formed by the silver element and the common conductive backing of the mosaic surface. Electric currents of corresponding intensity and frequency, produced in the associated circuit, were used for modulating the carrier wave of television broadcasting.

The electron-camera of Farnsworth consisted of an evacuated cylindrical tube at one end of which was a photo-sensitive surface. At the other end was the camera lens which projected the scene to be televised on the photo-sensitive surface. The electrons emitted from the surface could be drawn off by means of an anode in the form of a small cylindrical tube placed in front of the lens. There was a small hole on the side of the cylinder through which the electrons could enter into the cylinder and fall on a tiny collecting disc placed in the centre of the cylinder. The novel feature of the electron camera was a system of coils and plates, which carried current or was electrically charged and which bent the paths of the electrons emitted from the different parts of the illuminated photo-sensitive surface in such a manner as to produce a real image of the picture on the photo-sensitive surface, made not of light but of electrons only. The function of the magnetic field and the electric field was analogons to that of a lens which deviated light rays, emanating from different points of an illuminated object, in such a way as to form a real optical image of it. The invisible electron image, faithful in every respect to the optical image on the cathode surface, was formed in front of the above-mentioned anode cylinder and was caused to move horizontally and vertically (by suitable electric fields) so that every part of the image passed in succession in front of the tiny hole in the anode cylinder and allowed electrons from the corresponding part to enter and fall on the collecting disc within. Small electric currents proportional to the number of electrons falling on it—which latter in their turn were proportional to the tone value of the particular element of the image on the photo-sensitive surface from which they had been emitted—were developed in the circuit associated with the collecting disc. The fluctuating currents after suitable amplification were made to modulate the carrier wave in the usual manner. The scanning device known as picture analyser or image dissector had been remarkably developed by Farnsworth.

It was to be seen that in both the iconoscope and the electron camera there were no mechanically moving parts. The scanning was done by the movement of an electron beam or an electron image. These being practically weightless could be moved with as great a rapidity as one wished and further, their movements could be controlled by simply turning the knobs which governed the strength and frequencies of the currents, etc., producing the controlling magnetic and electric fields.

Transmission—Difficulty of Side-Band

For television broadcasting three things had to be transmitted from the sender: (1) the vision signals obtained by scanning, (2) synchronizing signals to enable the scene to be reconstructed at the receiver in correct frame and shape, and (3) the sound.

These signals were transmitted on two channels, one took the vision and the synchronizing signals and the other the sound. The channels usually employed for the purpose were ultra-short radio-waves of wave length 5 to 7 metres. The reason for using such high frequency was to limit the width of the side-band, when the carrier wave was modulated by vision signal. On 6 metres, high definition modulation covered a range of 5.9 to 6.1 metres, while similar modulation on medium wave of 300 metres would cover a range of 150 to 600 metres. With the increase of television service, it was possible that cables would be employed for carrying the radio-waves from one station to another. Such cables consist of metallic tubular casings about 2.5 to 5 centimetres in diameter with a thin conducting wire running down the centre of the tube. The cost was rather high, but they had already been laid in Europe and America and were working successfully.

Reception of Television signals—Synchronization

The receiver reconstructed the image, and for this purpose it was necessary to convert, in sequence to their proper light and shade value, the electric pulses carried from the transmitter. As in the transmitting side this could be effected either by mechanical or by electronic device. As already mentioned the latter was now in most common use. The function of the synchronizing impulses was most important. If these were not present it would be impossible to rebuild the received picture in step with the transmitted picture and what was white in the original might not be so in the image.

As regards developments in actual television broadcasting, Prof. Mitra said that the countries in which notable progress had been made were England, Germany, France, and America.

In England a committee was appointed in June 1934 at the instance of the Postmaster-General "to consider the development of television and to advise the Postmaster-General on the relative merits of the several systems and on the conditions under which any public service of television should be provided". The committee were satisfied that high definition television had already reached a practical stage, and accordingly recommended that the B. B. C. should inaugurate and operate the service using apparatus of Baird Television Ltd and of the Electrical Musical Instrument Co. (Marconi) Ltd.

RECENT PROGRESS IN TELEVISION AND IONOSPHERIC RESEARCH

There were in England thus two television services maintained by these two organizations. The former was exploiting the original Baird process (mechanical scanning) as well as the electron-camera of Farnsworth, and the latter the iconoscope of Zworykin. Prof. Mitra was able to visit the Baird Laboratory at Crystal Palace, London, through the courtesy of Capt. A. G. D. West, *the technical director* of the Company. The laboratory was self-contained and was constructing for its own use cathode ray oscillographs, electron multipliers, receiving valves, etc. Important investigations on the propagation of ultra-short waves was also being carried on here under the direction of Capt. West. The actual broadcast transmissions were made from Alexandra Palace where the studio was equipped for televising all types of subjects suitable for programmes.

In *Germany the Fernseh A.G., Telefunken,* Tekade and Loewe were developing television. All these were now, however, more or less under State control. Prof. Mitra visited the laboratories and studios which were directly under the Posts and Telegraphs Departments, through the kind intervention of Postrat Harder, an official of the Postal Department—Reichspostzentralamat. The method of scanning was mechanical—disc-scanning by spot light. Remarkable development had been made in this system of scanning and the definition of the pictures with 180 lines was extremely good. The actual transmitter was at Wintzloben in the outskirts of Berlin. The wavelength was 7 metres and the antenna, a quarter wave vertical rod with round counterpoise at its base, was erected on the top of Rundfunkturn—a hundred-metre tower. Regular television programmes were broadcast every evening. There was, however, as yet no regular "viewing and listening" public. At the Radiohavs, the studio of the Berlin Broadcasting, there was arrangement for giving public demonstration which attracted a fair number of audience every evening. Prof. Mitra also witnessed the vision-telephone service—the Fernsehsprechdienst—between Berlin and Leipzig. A subscriber at Berlin could ring up another at Leipzig and could carry on conversation with him while he saw his face on a screen in his front.

Television in France was being developed mostly by the P. T. T., the Post and Telegraph Department. Prof. Mitra was able to witness a demonstration in the studio of the Department through the courtesy of Prof. Gutton and of M. Barthelemey, minister of P. T. T. The scanning was by the Nipkow disc and the studio was brilliantly illuminated by flood light. As a consequence it was uncomfortably hot. The faces and the dress of the artistes were 'made up' so as to give pronounced contrasts in black and white. All these were in strong contradistinction to the 'spot light' scanning as employed in Germany and in England in which the studio was practically in the dark and no 'make up' was necessary. The reception was by the usual cathode-ray tubes. The picture was of fairly good quality and of the standard size 30 cms. by 23 cms.

Television development in America was in the hands of two organizations—the R. C. A. and the Farnsworth Television Inc. The former was exploit*ing the iconoscope of Zworykin and the latter* the electron-camera. Prof. Mitra had the opportunity of visiting Farnsworth's laboratory at Philadelphia where extensive research work on electron-optics, dissector tube, and on electron-multiplier was being carried on. The electron-multiplier was a remarkable device which amplified the feeble photo-electric currents developed by the scanning of the electron-image in the dissector tube. The device utilized the econdary emission of electrons and sconsisted essentially of an evacuated cylindrical glass envelope at each end of which there was a photo-sensitive cathode (caesium-coated nickel). Photo-electrons emitted from one surface were accelerated by an electric field and impinged on the other surface. Secondary electrons emitted from the latter surface were in their turn accelerated by the electric field (which was an alternating one of high frequency about 50 cycles per second) and, impinging on the first surface, released secondary electrons in great number. The process went on until checked by some special device, and very large current could thus be built up from a current of very feeble intensity of photo-electric origin. In an actual demonstration witnessed by Prof. Mitra it was seen that the light from an ordinary electric torch could produce a current of several milliamperes. The most useful feature of the electron-multiplier was that its noise-amplification ratio was much smaller than that usually obtained in a triode valve amplifier of most careful design. Prof. Mitra was of opinion that besides its application in television the electron multiplier would soon find a very useful place in the physical research laboratories. The Farnsworths were three brothers and the eldest, still on the right side of forty, was the head of the firm. The establishment of the Farnsworth organization and the recent success which had crowned its efforts were examples of American enterprise and farsightedness. It was very recently that the Farnsworth's system of television had begun practical television on a commercial scale. But enterprising private individuals were not wanting, even twelve years ago when there was hardly any prospect of immediate return on outlay to finance and encourage the young Farnsworth. Hundreds of thousands of dollars had literally been spent and it was now bearing fruit. As explained before, the combination of the electron-camera and the electron multiplier—or the dissector multiplier as it is called—was an elegant example of the application of the principles of electro-magnetism and of photo-electricity and had great future before it.

Ionospheric Research

With regard the development of ionospheric research Prof. Mitra said that the principal centres of such research in Europe were Halley Stewart Laboratory, National Physical Laboratory, Cavendish Laboratory, Marconi Research Laboratories and Imperial College in England, Heinrich Hertz Institut and Technische Hochschule (Munich) in Germany, Righi Institute (Bologna) in Italy, Nordlysobservatoriet (Tromsö) in Norway, and Philip's Gloeilampen Fabriken (Eindhoven) in Holland.

In England

Prof. E. V. Appleton was the foremost worker in England. He had till recently been working at the Halley Stewart Laboratory at Hampstead, an outlying suburb of London, but on the retirement of Prof. C. T. R. Wilson he had been appointed the Jacksonian Professor of Physics in Cambridge and had left London. Dr F. W. G. White of King's College, who was a collaborator of Prof. Appleton had gone to New Zealand and hence it seemed that ionospheric investigation in London would be at a standstill for some time. Amongst the investigations which were being carried on at Prof. Appleton's laboratory mention could be made of reflection coefficients of ionospheric layers, measurement of collisional frequency, effect of magnetic storms on the ionization etc. The transmitting station was at the King's College and the receiving and recording equipments were at Hampstead at a distance of about 8 kilometres. There was provision at the transmitter for varying the wave frequency continuously. At the receiving station a suitably arranged camera recorded the so-called (P'-f) curve-variation of the equivalent height of a particular ionospheric region as the exploring wave frequency is varied. Both the transmitter and the receiver were operated manually.

The National Physical Laboratory maintained a Radio Research Department of which, till lately, Mr R. A. Watson Watt was the superintendent. He had recently joined the Air Ministry and his place had been taken up by Dr R. L. Smith Rose. The headquarters of the Department were in the main buildings at Teddington but the experimental laboratories were situated at Slough, a small village about 30 kilometres west of London. Excellent facility was provided for fieldwork since there were extensive open grounds all round the laboratories. Among the investigations carried on here one could mention ionospheric measurements, recording of atmospherics, and measurements of the angle of incidence of downcoming waves. For ionospheric observations elaborate apparatus had been devised for making automatic records of the (P'-f) curve. The transmitter and the receiver were located in different huts separated by a distance of about 50 metres. The original equipment was, what one might say, semi-automatic, *i.e.*, the frequency at the transmitter varied automatically over a certain range while the receiver was kept in tune by the observer manually. Recently, however, fully automatic system had been developed and records of the $(P'\text{-}f)$ curve were obtained automatically every one hour or half an hour as desired. Mr Bainbridge Bell was largely responsible for the design of the apparatus. The observation was being carried on by Mr Naismith, Miss Ingram and others.

In connexion with long-distance short-wave propagation it was very important to know the angles at which downcoming waves leave the ionosphere. This was being measured with the help of two horizontal aerials placed about one wavelength apart. A knowledge of the difference in phase of the high frequency currents developed in the two aerials by the downcoming wave enabled one to calculate its angle of incidence. The whole equipment was calibrated by observation on waves received from a tiny transmitter carried up by a kite. Mr Barfield was in charge of this section and the observations were being made by Mr Slow.

Excellent work was being done on atmospherics by Mr Lutkin under the guidance of Mr Watson Watt. Apart from the automatic directional recording of atmospherics, the Slough station kept watch over interesting phenomena in this connexion simultaneously with a similar station in Scotland with which it was in telephonic communication.

Atmospherics were also being studied at King's College by Dr F. W. Chapman. An aerial of large capacity in the form of an elevated sphere as designed by C. T. R. Wilson for measuring fields of thunderstorms was employed for the purpose, and wave forms of the atmospherics were recorded by means of a cathode ray oscillograph. The whole equipment worked automatically and was so arranged that records were taken only when the aerial was charged by an atmospheric above a certain minimum potential. Observation at King's College (and also in Norway by Norinder) showed that the electrical disturbance set up by an atmospheric could be divided into two groups: one a group of high frequency waves (2500 to 10.000 per second) and the other a group of low frequency (250 per second). The two groups travelled with different velocities. For thunderstorms of near origin the former was superimposed on the latter. For the distant ones the two groups were separated and knowing the time-separation it was possible to calculate the distance of the origin of the atmospheric.

At Cambridge, Mr Ratcliffe was engaged in investigations on polarization of downcoming waves, reflection and absorption coefficients of different ionospheric regions and on collisional frequencies therein. The transmitter and the receiver were about one and a half kilometre apart and were connected by land lines. The former was located in an old building of the Solar Physics Observatory and the latter was in a hut in an open field. Six different wavelengths were employed at the transmitter and the observer at the receiving hut could operate the transmitter from there and bring any one of the wavelengths into operation.

Mr Eckersley of the Marconi Research Laboratory at Chelmsford was engaged in studying the scattering of waves from the ionosphere. There was reason to believe that the ionosphere might have a 'patchy' structure, and if the size of the patches was comparable with the wavelength employed, then it was possible that when the refractive index of the patches approached zero value there would be copious scattering. Very powerful transmitters had to be employed to study the scattering phenomena. Mr Eckersley was, however, fortunate in this respect, because he could avail himself of the high power short-wave commercial transmitters of the Marconi Co. Records of echoes from great heights indicating the existence of ionospheric layers at 1000 km and above were reported by various observers from time to time according to levels of the ionosphere.

Mention was made of another ionospheric investigator, Dr J. Hollingworth, who had done important work in connection with the sudden change of polarization of long waves during sunrise and sunset. Unfortunately it had not been possible for Prof. Hollingworth to continue his investigation since he took up the professorship of electrical engineering in the University of Manchester. It is difficult to obtain facilities for such investigation in a crowded city.

RECENT PROGRESS IN TELEVISION AND IONOSPHERIC RESEARCH

At the Imperial College of Science and Technology, London, theoretical investigations of great importance on questions relating to the ionizing influence of solar radiation, origin of electrical current system in the upper atmosphere responsible for diurnal variation of terrestrial magnetism, action of charged and uncharged particles emanating from the sun on upper atmospheric ionization, connexion of the former with magnetic storm and on similar other questions were being carried on under the inspiring guidance of Prof. S. Chapman.

The problem of ozone in the upper atmosphere was now concerning ionospheric investigators on account of the recent discovery of ionized layers in the lower and middle atmosphere. The main centre of ozone research in England was at Oxford where Dr Dobson was conducting valuable observations in this field. He had recently developed a very compact and ingenious apparatus for determination of the ozone content from observation of the light of the zenith sky. The apparatus worked even when the sky was clouded and was very rapidly working; only about 10 minutes sufficed for obtaining the actual ozone content from the observational data.

The Radio Research Board

Prof. Mitra laid particular stress on the great impetus given to ionospheric and allied investigations in England by the Radio Research Board. The Board was originally established in 1920 for co-ordinating radio research carried out by the fighting services and the Post Office and to provide for research work of a fundamental nature. In recent years it had been devoting more and more attention to the second part of its programme and was engaged in effecting closer co-operation between men engaged in the practical advances of the art of wireless signalling on the one hand, with men of science well versed in the physical foundation of wireless on the other hand, without which satisfactory progress in the art of radio was impossible. The Board was controlled by representatives of the Admiralty, the Post Office, the Meteorological Department, the War Office, the Marconi Co., and the universities, and independent physicists. At the present moment most of the radio research work at different centres in England was being carried on at the instance and the initiative of this Board. The funds were being supplied from the National Physical Laboratory, the Department of Scientific and Industrial Research, and from contributions made by various other government departments and scientific bodies. Such bodies with similar object and constitution had been founded in Canada, Australia, and Japan and were entirely financed by their respective governments.

In Germany

In Germany, ionospheric studies were being carried on at two places: in Berlin at the Heinrich Hertz Institut and in Munich at the Technische Hochschule. At the former Prof. Wagner was for a long time the director, and was responsible for organizing the second Polar Year Expedition at Tromsö. He had recently retired and the present director was Dr Leithäuser. The ionosphere apparatus was not located at the Heinrich Hertz Institut which, on account of its being in the heart of the city, was liable to interfering disturbances, but had been erected in the outskirts of the city. Continuous record of the heights of the various ionospheric regions was kept there. At Munich, Dr Goubau was carrying on valuable work under the guidance of Prof. Zenneck. Here also continuous record of ionospheric heights was kept and, in order to avoid parasitic electrical noises, the equipment had been erected in a place about 80 km from the city of Munich. At both Berlin and Munich evidence of reflection from great heights (1000 km and above) had been obtained.

France, Norway and Italy

Practically no ionospheric work was being done in France. M. Jouast of Laboratoire Central d'Electricité was the only person interested in the problem. He intended to start work in this field in near future.

RECENT PROGRESS IN TELEVISION AND IONOSPHERIC RESEARCH

Other countries in Europe where important ionospheric work was being carried on were Norway and Italy. The name of Tromsö in the former was now familiar because it was in this small town (Lat. 69°40′ N/Long. 18°57′ E) that the observations during the second polar year were carried out under the joint auspices of British National Committee and the Norwegian Government. The observations were being still continued at the Nordlysobservatoriet of which Prof. Harang was the head. In Italy Prof. Ranzi was investigating the connexion between thunderstorms and upper atmosphere ionization at the Righi Institute, Bologna. Unfortunately, for want of time, Prof. Mitra was unable to visit these important stations.

In the United States

In the United States of America at West Virginia, Prof. Colwell and his associates were working on this subject. Their receiver was very well designed and, besides the echoes from the middle atmosphere (55 km and 25 km), which were originally detected at Calcutta, they had been able to obtain echoes from so low a height as 5 km. The origin of these low height echoes was still uncertain but the experimental evidence in favour of their existence seemed to be indisputable.

At Washington, the ionosphere was being studied in two laboratories, one was the National Bureau of Standards and the other at the Department of Terrestrial Magnetism of the Carnegie Institution. At the former Messrs T. B. Gilliland, S. S. Kirby, D. M. Stuart, N. Smith and S. E. Reymer were engaged in the work. The multifrequency automatic recorder originally devised by Gilliland was erected at Bellsville station about 24 kilometres N. E. from the Bureau of Standards buildings. Another recorder with many improvements over the original one was now at work at another station at Meadow Field. Mention was made of a particularly useful equipment at the latter place. An automatic recorder of field strength registered the diurnal and seasonal variation of signal strength and the periodicities of signal fadings of near and distant stations. A close study of these records enabled one to trace the nature of the paths followed by the indirect rays from the transmitter to the receiver through the various regions of the ionosphere.

At the Department of Terrestrial Magnetism of the Carnegie Institution of which Dr Fleming is the head, Dr L. V. Berkner along with Mr H. W. Wells and E. B. Judson were engaged in ionospheric investigation. Berkner and his associates, Wells and Seaton, had developed an automatic recorder for the so-called (P′-f) curve. It was erected at Kensington Field about 7 kilometres from the buildings of the Department. The equipment was fully automatic and was one of the best of such types of apparatus. Four of these were being constructed, one for each of the following places of observation: Washington, Alaska (Canada), Huancayo (Peru) and Weatheroo (Australia). Transmitting aerials with appropriate feeder system had been devised which kept the impedances more or less matched over a wide range of frequencies. The radiations from the aerials do not change greatly when the wavelength of the transmitter was continuously charged. Ionospheric work was also being carried on under the direction of Mr E. O. Hulbert at the Naval Research Laboratory, Washington. Prof. Mitra could not visit the laboratory as it was not open to foreigners.

At the Bell Telephone Laboratories at Deal, New Jersey, two well-known investigators, Messrs W. M. Goodall and J. P. Schafer were carrying on very important work on diurnal and seasonal variations of the ionosphere and on the effect of meteors. There transmitter and receiver were both located side by side and could be operated by one and the same observer.

Another place in the States where ionospheric investigations were being conducted was the Cruft Physical Laboratory at Harvard under Prof. H. R. Mimno. Here also there was arrangement for automatic records and a vast amount of data regarding ionospheric heights and densities had been collected. Records of reflection from great heights which are called G layer by Prof. Mimno had been obtained.

Prof. Mimno was being assisted in his work by Mr H. Selvidge.

Mention was made of another institution, the Blue Hill Observatory about 20 km. from Harvard, where very interesting observations on the signal strength of ultra short waves (5 to 7 metre) were being made. The signals were found to reach well beyond the optical range (which is limited by the curvature of the earth) and sometimes showed abnormal strength. Dr C. F. Brooks was in charge of this observatory. It was believed that there is strong correlation between abnormal signal strength and temperature inversion in the upper tropsphere. (The latter was obtained with the help of radio-meteorographs). The results were of obvious importance in connection with the radio echoes from low heights as observed by Prof. Colwell at West Virginia and also with regard to television transmission on ultra short waves.

Investigations in subjects allied to the ionosphere were being conducted by Mr O. H. Gish and by Mr G. McNish at the Carnegie Institution. The former had made systematic analysis of records of conductivity obtained by stratosphere balloon flights, particularly that of Explorer II on Nov. 11, 1935. The latter had made important study of the electric current system in the upper atmosphere which could be responsible for producing certain types of magnetic disturbance.

The B. B. C.

Professor Mitra had also the opportunity of visiting some of the B. B. C. transmitting and research stations through the courtesy of the Chief Engineer Sir Noel Ashbridge. Mr. L. W. Hayes, Dy. Chief Engineer arranged the trips and the following stations were visited. The B. B. C. National Transmitter (150 KW), Droitwich, the short wave Empire Station, Daventry, the B. B. C. research station, Nightingale Square, London and the frequency standardizing station at Tatsfield.

The B.B.C. organization consists mainly of a head office and a number of regional transmitters each serving a particular area of Great Britain and N. Ireland. These stations are linked together by high grade telephone lines so that, if desired, it is possible to broadcast simultaneously the same programme from all the stations. The so-called National Programmes belong to this class. Each station also organizes programmes adapted to its special needs and broadcasts what is called Regional Programmes. The two programmes are on two different wavelengths. It was proposed sometime ago that there should be a central high power station situated at some convenient place which would transmit on long wave and serve the whole of the British Isles. The National Transmitter at Droitwich was the outcome of this proposal. The Droitwich Transmitter was equipped with the latest improvements and worked on a wavelength of 1500 metres. Unlike the regional stations, the D. C. power here was obtained by conversion from A.C. rectified by mercury-arc rectifiers. The aerial system was a single wire T-aerial supported by two 700 ft masts. Besides this large transmitter, Droitwich has also a 50 KW transmitter working on a medium wavelength for serving local area.

Of the regional transmitters five were more or less of the same type and were 50 KW each. Two recent ones, one near Belfast, N. Ireland and the other at Burghead in N. Scotland were of more recent type. The first was 100 KW and the second 60 KW.

The object of the short wave Empire Station at Daventry was to serve the whole of the British Empire. The range of wavelength used was from 11 to 50 metres. There were six transmissions during 24 hours and they were so arranged that an evening period in some part of the Empire received a programme. The wavelength and the aerial system were also changed to suit the hour of the transmission and the country intended to be served. The necessary frequency change in the transmitter was carried out manually by changing the appropriate coils etc., in the oscillatory circuits. The general design of the aerial system was simple. It consisted of a number of half wave aerials (generally

4 to 5) stocked one above the other seperated by half wavelength and supported from two 500 ft. masts. Experiments were being made by tilting the plane of the aerial system to find out the direction in which the waves should be projected to produce the most effective result. The whole equipment—the aerials and the transmitter—were still in experimental stage and reports from listeners all over the world were being collected to gain information about the most suitable wavelength, the type of the aerials and the hours of transmission for a particular country.

The research station of the B.B.C. at Nightingale Square, a suburb of London was established for carrying out researches on engineering problems arising out of the technical development of broadcasting transmitters. Professor Mitra met there Mr H. L. Kirke, head of the research department, who, it might be remembered, came out to India last year as an expert to advise the Government of India on the future development of broadcasting. Amongst the researches which were being carried on here one could mention development of ribbon microphone, field strength of ultra short waves in connection with tele-broadcasting, studio acoustics etc.

At Tatsfield, about 15 miles south west of Nightingale Square, frequencies of the B.B.C. transmissions and also of continental stations were checked and measured with great accuracy.

SWANSCOMBE SKULL

The occipital the left parietal complete bones of the Swanscombe skull have been discovered in June 1935 and March 1936 respectively. Both were found in the same layer and 24 feet below the surface of the earth and in the mid-gravels of the lower Thames at Swanscombe in Kent.

According to Marston the occipital bone of the Swanscombe skull differs markedly from the Neanderthal type but approximates closely to the Piltdown type. Marston says, "It is felt that the new skull is to be regarded definitely as a precursor to the Piltdown type." In his opinion Swanscombe is more primitive than the Piltdown.

Minendra Nath Basu.

The Education of Subnormal Children

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UPTO the present time the problem of educating subnormal children has not received any special attention of the educationists in this country. In other civilized countries of the world, we find special provision made for their education. Medical men have co-operated with psychologists in conducting researches for finding out the best method of educating them. Educational experiments are made and schools are organized in accordance with principles successfully established by such experiments. Ours has been a policy of indeterminism in educational matters; but we can no longer afford to follow this policy of mere drift, for it affects very adversely the well being of the nation. The results of educational experiments show that all children cannot be treated alike. What is meat for the normal child may be poison for the subnormal.

The problem of educating subnormal children is divisible into two minor problems: *(i)* the problem of educating the aments, *(ii)* that of educating the backward. Let us consider each of these problems separately.

The aments fortunately form a very small percentage of the school going population. In England they have been estimated to vary from ·75% to 1·5% of the total number of the children of school-going age in different counties. There are about 200 schools for such children in the United Kingdom. The aments include the idiots, the imbeciles and the feebleminded. In the case of such children there is some marked defect in the constitution of the brain. They are absolutely incapable of higher processes of cerebration, and even their perceptions are confused and blurred. In a great number of cases the power of inhibiting the impulses or forming resolutions is very feeble, and they seem quite incapable of sustained effort. Ordinarily aments are a burden to society. Some are incapable of taking care of themselves and some merely swell the number of paupers and criminals in the country. To make something out of them and to prevent them from becoming anti-social the state should take upon itself the responsibility of imparting such knowledge and training to them as will enable them to earn their living and to adjust themselves properly to their social environment.

The aments can be easily distinguished from the normal children by their ungainly appearance, unsteady movements, awkward manner of handling objects and disconnectedness in speech. They are unable to answer correctly simple questions regarding their relatives, homes, or give description of places seen. They cannot make simple additions and subtractions. Their power of visualizing objects, of comparing one with another is very limited. They can describe things present before their eyes to a certain extent but the past impressions are not clearly retained. If we try to know their past history we would find that they took longer time in teething, acquiring the power of speech, and ability to stand and walk. Some children of this type are found stammering in later life also.

The aments require to be taught in special schools by specially qualified teachers. Seguin in Belgium conducted experiments and has evolved the well-known Decroly Method of teaching them. According to Seguin, "education consists in the adaptation of the principles of physiology through physiological means and instruments to the development of the dynamic, perceptive, reflective and spontaneous functions of the youth." The teacher has to aim at enabling the aments to control their muscles and at training their senses. What we find in a Montessori school done with normal children we have to do in the case of the aments also who are usually quite grown up. The first lessons will consist of handling objects, keeping them in proper places and arranging them according to a particular order. Of course the objects will be different from those found in a Montessori school. After these preliminary lessons in control of muscles they would be given sense-training. Each sense is to be trained as far as possible in isolation from others. They would be taught to distinguish the shapes and sizes of objects, and differences of colour and sounds. Similarly the idea of weight will be given by actually making them lift objects of different weights. In this way the several senses—the eye, the ear, the nose, the mouth, the skin and the muscles—will be separately trained.

The foundation of all mental development is perception and since the perceptions of the ament are usually blurred and faulty it is necessary to give him sense-training to enable him to have correct perceptions. If the impressions come in rapid succession he fails to pick them up as they come and to sort them into their proper groups at once, as is done by the normal mind. Before one impression is cognized another comes in and the two get mingled, so that, the net result is only a blurred and vague consciousness of objects. Hence the process of education would consist in giving sense-training to the child in such a way that each sense is trained slowly, *accurately, and separately from* others. At a later stage the teacher will try to impart them knowledge of objects as a whole and ask them to perform simple activities. Thus gradually 'the synthetic activity of consciousness' will be awakened and the child will be intellectually improved.

It cannot, however, be hoped that the ament would come up to the mental stature of the normal child. But surely something can be made out of him by giving him proper education. During an experiment conducted by Madame Montessori at Rome in the education of the feeble-minded children, some of them after being educated by this method for a time grew so much in intelligence as to obtain scores equal to normal children in intelligence tests administered to them. Consequently they were transferred to ordinary schools. But we may say here that these cases of so-called aments were not cases of real aments, but of children who, due to some environmental causes, showed themselves inferior to ordinary children. Prominent among such causes are disease, malnutrition, unhealthy habitation, and improper care during the early period of life. As to developing the intelligence of real aments, psychologists are of opinion that "no means exists or will ever exist by which we can supply intelligence to the mentally deficient. Each of these children has a certain capacity for development and in the absence of appropriate training will remain undeveloped".

The subnormal child requires much more individual attention than the normal child. The classes of such children consist of 12 to 15 children. There should always be an atmosphere of encouragement and the child should be made conscious of the success attained by him at each stage. His curiosity and interest in objects and things round him should be aroused. The teacher has to work according to the interests of the child. There should be little in the curriculum requiring abstract thinking, or literary training. Manual occupations should occupy the major portion of his time. A great many of the aments are interested in music and this taste should be developed by proper training. Similarly they should be given training in drawing and painting.

There are two classes of aments *viz.*, the sluggish and the excitable. The former are slow in movement and the teacher has to make them active by creating in them an interest in activities going on all round them. They should be encouraged to take part in games, running,and music drill. They ought to be engaged in some form of bodily activities to enable them to shake off their inertia.

The aments of the excitable nature have little power of concentrating attention on anything whatsoever. They should be given work that requires sitting at one place, fixing attention on particular objects and making bodily movements steady. Exercises in paper-cutting, drawing, painting, woodwork and gardening are found very suitable to such children.

The aments are to be introduced gradually to the three R's. In teaching these subjects the teacher should apply the Decroly Method which consists in making everything concrete. The child is to be enabled to learn by actually doing things. He will be asked to note certain features of common objects and animals and describe them in his own language as accurately as possible. Thus his imagination will be developed. While teaching arithmetic he will be given ideas of weights and measures by actually weighing and measuring objects with his hands. He will be taught additions, subtractions and multiplications with the help of beads and pebbles.

Let us now take the problem of educating the backward children. They are below the normal in intelligence, yet are not so mentally deficient as to be classed among the aments. Their I.Q. as measured by intelligence tests is found usually between 75 and 90, whereas the aments have an I. Q. below 75. Most of such children belong to the class known as dull. Socially the problem of their education is far more important than that of dealing with the aments; for, as Dumville points out, "on the one hand they are much more numerous and on the other they will repay far more than the mentally deficient for the care bestowed upon them." They form about 12 to 15 percent of the school going children. No effort in our country is made to find such children out, much less to devise methods for educating them. They are usually put in the same class as the ordinary children and are required to complete the same course of study as the latter do. The result is that the backward child being unable to keep pace with the normal one, does not profit much by school instruction. He often fails in annual examinations and each time he is detained from promotion to a higher class and made to study in the same class again. This hardly brings any improvement in him. As he has to study the same subjects and usually the same text books over again, the task becomes dull and monotonous. His curiosity and initiative are thus killed. Further he suffers in self-respect as he has to bear the humiliation of failure and to sit with children younger than himself. They always look down upon him. He carries with himself a defeatist mentality all his life and so when he comes out of educational institutions he is found lacking in the spirit of enterprise and has seldom the courage to take up new ventures.

The normal children also suffer on account of the presence of backward ones among them. The teacher has very often to adjust his methods to suit the needs of the latter, and consequently the lessons become dull and boring to brighter children. Again these backward children are usually much older in age than the normal children of the same class. This brings about several emotional situations which are very difficult to solve. The moral tone of the class deteriorates. In this way both the backward and the normal children suffer intellectually as well as morally.

It is the duty of the educators to find out the backward child at an early stage to ascertain whether the defect is congenital or is acquired, and to devise proper means for his education.

The backward child cannot be so easily found out as the ament can be. There is nothing in his outward appearance, behaviour, or speech to distinguish him from normal children. The movements of the limbs of the body are well coordinated and in some cases he excels normal children in physical activity—such as, drill, games, running, jumping, gymnastics, and performing acts requiring nice bodily adjustments. As a matter of fact, interest in physical activity is one of the chief merits of such children. We cannot also find them out in ordinary conversation, for they are usually only 12 to 15 per cent below the normal in intelligence, and are pretty well acquainted with the environment in which they live, and know how to deal with different kinds of people. The examination results of the school also do not help us here much, for in a number of cases, specially in lower classes, such children by sheer industry manage to get the minimum pass marks, whereas brighter ones due to negligence fail. But these children are capable merely of rote learning and doing mechanical work. They do not really appreciate the true worth of the studies and can make little use of them in later life. As they advance from class to class they fail in increasing numbers, as the work in these grades becomes more definitely intellectual, and requires little of mechanical memorizing.

Intelligence tests have proved of special value in finding backwardness in children. Class examinations merely test a child's knowledge, they do not test his general educability, or intelligence as inherited by him. The acquisition of knowledge depends upon environment, whereas the child's intelligence is an inherited possession. It is given to him once for all. It is this possession which the intelligence test specially try to determine. "Mental tests" says Dumville, "are attempts to gauge the ability which a person possesses independent of any training or teaching. Thus to test the rapidity of reading ability of six year old children from different families and schools would not give us an indication of such ability. For some children are not encouraged to learn reading before the age of six, whereas others are. But to test them by asking each to repeat a sentence of sixteen syllables after one hearing of it would give us some indication. For all normal children of the age in question have heard and repeated a large amount of language."

In Europe and America a number of tests have been devised and they have been tried upon a large number of children of different ages. As a result of these psychological experiments, vocational guidance bureaus have been established and parents and guardians of children are advised to seek the guidance of experts in determining careers for their wards. The experts advise the school authorities also with regard to the education of children with different intellectual capacity and aptitudes. We stand sorely in need of such bureaus in our country. We have to devise intelligence tests of our own, embodying the principles of those devised in the West, but suited to our peculiar environments and habits of thinking. Attempts are being made at several places, by individuals and institutions, to devise such tests. When they are standardized we shall be in a better position to determine the educable capacity of each child than we are at present.

The school authorities can at present find out backward child from his general slowness in studies, his inability to grasp abstract ideas, and aversion to such subjects as mathematics and grammar. Such a child is often found reading in a class below the *one normally suited to his age*. In some cases it is due to late admission to the school, interruption in studies due to disease or accidental circumstances. These should be distinguished from cases of congenital backwardness. Some times myopia or slight deafness creates mental backwardness. When the defects of sight and hearing are removed such children regain their natural mental powers.

There should be some special arrangement for the education of the really backward children. In Germany there are separate schools for such children. There the method of teaching differs, and the syllabus of studies is completed in a longer period than the one fixed for ordinary schools. But the curriculum is the same. Children who make good progress in studies in these schools are later transferred to ordinary schools. This system, though it is good in many respects, has serious disadvantages. These schools are nick-named by the public as 'fools' or 'silly schools', and the boy who is sent to be educated there feels himself humiliated, He suffers in self-respect and this becomes a potent factor in the retardation of his progress. Further, the courses of studies being the same he has to learn a number of subjects for which he has no aptitude. Lastly when he comes out of these schools, having always lived with the subnormal, he fails to adjust himself to the social environment of the normal people.

In America a different system has been adopted. In each district there is some ordinary school with an ungraded class. The size of the class is much smaller than the one for normal children. The children are not fed on the same intellectual pebulum as is found suitable for normal children. The children of these ungraded class mix with normal children during recess and games and other extracurricular activities, and they enter into competition with them in such activities. The ungraded classes are considered as special coaching classes and some children are promoted to ordinary classes when they are found fit.

We can adopt a modified form of the system, prevalent in America, for our backward children. We may put all the grown up boys in one section of a class and allow them to take up subjects which require more of practical work rather than of abstract thinking. It should not be necessary for them to learn as much of mathematics and grammar as the normal children do. Their energies may be directed to manual employment, acquisition of arts and crafts, and to the study of such subjects as botany and agriculture. The backward children, though they cannot keep pace with the normal in studies, do quite well in life. They succeed as farmers, traders, carpenters, and artisans. Some of them have special aptitude for particular occupation and it will repay them much better in life if they tried to become masters in these, rather than waste their energies in the acquisitions of literary learning.

But the parents and guardians of such children may not need the advice of the experts when given. It may be due to undue faith in luck, predestination, or lack of faith in those who give advice. Another cause may be the general backwardness of our country in industries and commerce. There are few avenues of employment open in the country even for those who are intellectually superior and have acquired the requisite kind of technical and commercial education. Reform in education can only succeed when reforms in other directions also come in. Unless our industries are properly protected by tarrif walls and developed by a wise policy of state aid and encouragement, avenues for employment will not open in sufficient number to absorb the growing number of literates from our shools will continue rushing towards the universities for higher education however unsuitable it be for them. The other option is to work on the field as petty husbandman, or to be contented with the small workshop of the smith or the carpenter.

We have suggested above that the children who are below the normal in intelligence should be dealt with in a manner different from the one for ordinary children. But this must not lead one to suppose that the number of such children is very large in our school.

In this country there is no compulsory education which would have made children of even lower strata of society come to the school. Even where there is compulsory education, the percentage is 12 to 15. In India most of such children do not come to the school ; it is only the children of the more intelligent classes that do so. Hence the percentage is bound to be much lower as has also been found by the experiments made by the Benares Training College in testing intelligence. The results of public examination, however, show a different state of affairs. They would lead one to suppose that the majority of Indian people consists of subnormals. The real cause of the failures in the public examinations is the stress laid on the foreign language without mastering which there can be no success in the examinations. Nothing can be more unnatural than this, and it has produced the wrong impression of a general backwardness of the race. The result of experiments in psychology show that the learning of a foreign language is the most tiring of all the school subjects, and the normal child after the day's work is left with no reserve of strength to pursue, or cultivate any special interest. It is high time that educational reformers come forward to prevent this collosal waste of energy.

We have pleaded above for more education and for wider facilities for the education of all kinds of children, be they subnormal or bright. But we stress the need of giving different types of education to different types of students and of ammending accordingly the system of school organization. Of course there is a need for industrial reforms in the country to bring this about.

Eugenics Researches in Germany

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In ancient times we find many references of eugenics and human heredity. In some of the recorded works which have been preserved from these periods there may be found certain laws and regulations affecting the welfare of the human family. Manu's marriage laws show that in those days the knowledge of eugenics was not unknown in India. The Greeks, who rose to eminent heights a few centuries before the Christian era, had definite ideas regarding eugenics and incorporated them into regulations to be followed by all citizens.

Since the latter part of the nineteenth century the biological and sociological problems growing out of considerations of human genetics have led to the establishment of the modern science of eugenics. Charles Darwin, although he did not deal directly with eugenics, greatly stimulated work along this line by the evolutionary principles which he discovered. His worthy cousin Francis Galton is credited with being the real founder of the modern movement of eugenics. In the year 1883 this science was definitely established by him, who defined it as "the study of all the agencies under social control which may improve or impair the inborn qualities of future generations of man either physically or mentally". At first little progress was made but with the rediscovery of the Mendelian principles of heredity at the beginning of the twentieth century new impetus was given to the study of plant and animal genetics. The Mendelian principles of breeding disclose an experimental method of studying the manner in which the hereditary traits of individuals behaved among crosses in later generations. Later, in 1908, Professor Eugen Fischer of Berlin first applied these principles to the study of mankind and thus developed a new line in the study of anthropology. In the year 1913 Professor Fischer published his model work on "Rehobother Bastardvolk"a cross between Boer and Hottentot, by following the Mendelian principles.[1] Simultaneously in the same year Hermann Lundborg, the founder of des Institut fur Rassenbiologie in Uppsala (the Institute for Racebiology in Uppsala), published his famous work on "Researches on the families of the agricultural folks of Sweden, consisting of 2232 individuals on the medical and biological lines."[2]

After the publications of these two important works of Fischer and Lundborg the researches on human heredity have been adopted by almost all the biological institutes of the world, and at the present time it is fully established that eugenics is intimately connected with human heredity.

Realizing the importance of this science, Kaiser-Wilhelm Gesselschaft in 1926 called upon the well known German anthropologist and eugenist Professor Eugen Fischer to organize and conduct an institute for research into human heredity at the Anthropological Institute, Dahlem, which is at present known as "Kaiser Wilhelm Institut fur Anthropologie menschliche Erblehre und Eugenik" (Kaiser Wilhelm institute for Anthropology, human heredity and Eugenics). In the above institute of Professor Fischer researches on human heredity are carried on by the study of twins. Although Francis Galton was the first man to take up this twin study, at the present time, this is carried on very systematically. Foremost amongst those who do researches on human heredity by twin study is Von Otmar von Verschuer who was formerly one of the assistants of Professor Fischer's institute but at present he is the head of newly constructed Erbklinik at Frankfurt. He is trying to find out the relation between heredity and environment. In his important study on methods for distinguishing between mono- and dizygotic twins, with new facts on tuberculosis in twins, he investigated 80 pairs of tubercular twins. Where tuberculosis occurs in both the twin members, the environmental conditions were different in 10 cases, of which 9 were monozygotics (identical twins). Where the tubercular condition was different in both the members of the pair, environmental conditions were the same for 25 pairs, of which 7 were monozygotics and 18 pairs non-identical, showing that a similar tubercular condition in both twins, where the environmental condition is different, occurs with striking preponderance amongst the monozygotics. He concluded thereby that tuberculosis shows the existence of specific hereditary predisposition (Diathesis).[3]

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[1] Fischer, E, *Die Rehobother Bastards und das Bastardierungsproblem beim menschen.* Jena, 1913.

[2] Lundborg, H. *Medizinisch-biologische Familienforschungen innerhalb eines 2232 kopfigen Bauerngeschlechts in Schweden*, Jena, 1913.

Another assistant of Professor Fischer, von Muckermann had undertaken investigations into the fertility of some important social groups of German people. He published his researches under the title "Untersuchungen uber die differzierte Fortpflanzung am deutchen Volk" (studies of the differential fertility within certain social groups in Germany)[4], in which he said :

> "This is not to say that one can state boldly the biological superiority of one class over others, for each is indispensible; each can have its own absolute value, but at the same time there may arise, within a group, a stratum of degeneration caused by some specific cultural or biological circumstance contaminating the entire community. Thus, at all time, the proportional contribution of each group to the whole is a question of importance. It is a question of supreme moment in a period of diminishing fertility in a people. The present catastrophic fall, exceeding anything known in history, will, by comparison with periods of growth, reduce considerably the number of stocks which carry on to posterity the national heritage. The quality of the future depends now, much more than normal times, on all classes, it would only be a matter of counting heads from generation to generation leaving the qualitative make-up unchanged".

Important work on heredity of mental diseases is being carried on by Professor Rudin, the head of the geneological department of the German Research Institute for Mental Diseases which is a Kaiser Wilhelm Institute in Munich. He was the first to study the heredity of mental disorders from a genuinely modern point of view. In the above institute Professor Rudin with his colleagues Hans Luxenburger and Johannes Lange is carrying out researches on the above subject with the help of twin and family study. He, after examining 701 families in which cases of schizophrenia had occurred, found that among the brothers and sisters of patients both of whose parents were healthy, 4.5% suffered from schizophrenia. When one of the parents was a schizophrene, the percentage of schizophrenes among the brothers and sisters of schizophrenes was 6.2% (34 families). Among half-brothers and half-sisters only 0.6% were schizophrenes. These facts speak, moreover, in favour of recessiveness of the taint. So does the cirumstance that, among 700 cases, Rudin found that in 14 instances the patient were the offspring of cousins.[5] H. Hoffmann has found that, among 150 children of schizophrenes, 13 to 15 (i. e from 8.6 to 10%) suffered from mental disorder of a schizophrenic type. He shares Rudin's opinion that a doubly recessive determination must be at work, that is to say that two pairs of abnormal genes must be present, if dementia praecox is to result[6].

Rudin, Hoffmann, W. Strohmeyer, have supposed that heredity factors competent when acting homozygotically to produce schizophrenia may, perhaps, when acting heterozygotically, manifest their effects by the production of schizoid psychopaths[7]. If both parents were schizophrenes, in accordance with the notion of a recessive and an intermediate heredity, we should have reason to expect that all children would be schizophrenes, provided that there was a biological identity in the heredity of the malady in both parents. Certain families have been described in which this expectation would seem to have been fulfilled; but in other families the facts do not appear to fit the theory, because in these latter instances, there was no biological identity between the morbific heredities. E. Bleuler, who originated the name schizophrenia, regards the group of schizophrenias as comprising a number of biologically distinct anomalies[8]. The heredity of feeble-mindedness is, to a large extent, investigated by many German biologists. The instructive study by Reiter and his collaborator, Osthoff, found that of 250 children at Rostock School for feeble-minded children 60 (24%) had had feeble-minded fathers, 80 (32%) had had feeble-minded mothers, and 29 (11.6%) had had feeble-minded fathers and mothers. Thus 67.6% had feeble-minded ancestry. Of the 140 children, one or other of whose parents had been feeble-minded, 103 (73.6%) had one or more feeble-minded brothers and sisters. All the 29 children, both of whose parents were feeble-minded, had feeble-minded brothers and sisters ; and among the brothers and sisters of the children in this group 90.7% were feeble-minded and only 9.3% normal. In two families where one of the parents was feeble-minded there were 8 feeble-minded children. These data favour the view that there are dominant heredity factors of feeble-mindedness. But among 102 feeble-minded parents 64% had feeble-minded brothers and sisters, which suggests the co-operation of recessive heredity factors[9]. Frau Rudin-Senger obtained similar results from a study of the children in the Munich School for the feeble-minded[10]. Thus there must be recessive as well as dominant heredity factors capable of producing feeble-mindedness ; and in this instance, likewise, the heredity is usually dominant, and in the graver degrees it is usually recessive. In epileptic parents the case is the same. Professor Rudin has shown that there are recessive hereditary factors capable of causing epilepsy but perhaps in less common instances the disease may be produced by factors whose heredity is dominant[11]. It is not possible to discuss here a great deal of work on various other mental diseases which have been done by Rudin, his collaborator, and others.

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[3] *Bericht uber die 11 Versammlung der International-n Foderation Eugenischer Organisationen*. 1934.

[4] Muckermann, H. Untersuchungen uber die differenzierte Fortpflanzung am deutchen Volk. Report. *Proceedings, 2nd* general assembly of I. U. for the scientific investigation of population problems, 1932-

[5] Rudin, E. *Zur Verebung und Neuenstehung der Dementia praecox*, Springer, Berlin, 1916.

[6] Hoffmann, H. *Die Nachkommenschaft bei endogenen Psychosen.* Springer, Berlin, 1921.

[7] Strohmeyer, W. Zur Genealogie die Schizophrenie und des Schozoids, *Zeitschrift fur die gesamte Neurologie und Psychiatrie, 95,* 1925.

Dr Kretschmer of Germany is carrying on extensive research work on constitution and character. He has classified the people of Germany into three types :

(*i*) Asthenic.
(*ii*) Pyknic.
(*iii*) Athletic.

The asthenic type is lean, thin and tall, the pyknic is short and fatty, and the athletic type is muscular.

Kretschmer describes the types of physique and the constitution ; he elaborates the specific relationship of the pyknic and leptosmic body-build with manic depressive and schizophrenic psychoses respectively. For him body-build and psychosis, body function and disease, healthy personality and heredity are, "partial symptoms of the underlying constitutional structure".[12]

Researches are going on in Germany on the influence of alcohol over the offspring by Professor Lenz of Rassen Hygienische Institut, Berlin (Race-hygiene Institute, Berlin) and others. They are of opinion that in the population of Germany, alcohol would seem to play an important part among the causes of morbid heredity taints. In the offspring of alcoholics various kinds of mental disorders and feeble-mindedness are found in much above average frequency ; and in some of the cases, these changes seem to be hereditary. About one third of all epileptics, imbeciles, and idiots are the progeny of hard drinkers. Of course in many of these cases it may well be that the tendency to drunkenness in the parent (usually the father) was a manifestation of the same heredity factor which took effect in the children as epilepsy or imbecility. Among the parents of schizophrenes too, we find an unusually large number of alcoholics, for it would appear that the schizoid temperament predisposes to alcoholism.

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[8] *Lehrbuch der Psychiatrie*, Springer, Berlin.

[9] Reiter, H. und Osthof, H. Die Bedeutung endogener und exogener Faktoren bei kindern der Hilfsschule, *Zeitscrift fur Hygiene*, *94*, 1921.

[10] Rudin, E. Ueber Vererbung geistiger Storungen, *Zeitschrift fur die gesamte Neurologie und Psychiatrie*, *81*, 1923, nos 3 und 4.

[11] Rudin, E. Der gegenwartige Stand der Epilepsieforschung, *Zeitschrift fur die gesamte* Neurologie *und Psychiatrie*, 89 1924 nos 1 bis 5.

following types.

[12] Kretschmer. *Korperbau und charakter*.

The German Government, realizing the importance of race hygiene for the welfare and prosperity of the entire nation, have enforced laws for the prevention of hereditary defective progeny and improvement of the habitual criminal and of the social criminal. Courts and high courts for cases of heredity have been established in which two physicians and one judge decide whether one is to be considered as hereditary defective in the sense of the law. Besides these, the Government have enforced laws for castrating moral criminals. Thousands of moral crimes are committed on small girls and women, each year. Formerly these criminals, after some imprisonment, were released and were free to commit fresh crimes. Now the court can decide on the castration of the dangerous moral criminals, and thereby extinguish the sexual impetus to a certain degree. Thus it is made impossible for the criminal to transmit their abnormal criminal predisposition to progeny. All of these measures are for bringing the German nation to the endeavours of hereditary health purity. In order to reach this goal, health centres have been established in the city and country districts. There are advisory boards for the fostering of heredity. The activities of these advisory departments are for the guidance of those people who have decided to marry and to advise married people and families, particularly when a hereditary defective child is born. The aim of these is *(i)* to keep the physically and mentally unfit from marrying and as far as possible from procreation, so that undesirable progeny may be prevented, *(ii)* to make marriage between hereditary healthy and hereditary defectives impossible, but to permit marriage among the sterilized, *(iii)* to arouse the feeling of responsibility in regard to the coming generation, and thus to influence the selection of a mate in a hereditary healthy respect.

German Government have enacted laws for persons suffering from a hereditary disease to render them incapable of procreation by means of surgical operation (sterilization). The sterilization is so carried out that without removing the testes or ovaries the spermatic cords or the fallopian tubes are severed. Sterilization has no ill effects on the health of the man or the woman. Sexual pleasure and the ability to have sexual intercourse are in no way affected. Sterilization, in cases prescribed by science, should be regarded as a humane duty. It is in the highest sense inhumane to tolerate quietly the creation of human life to which fate has meted out suffering which cannot be prevented.

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* Read before the Bengali Society of German Culture, on December 23, 1936.

Lignin

(Continued from the last issue)

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Oxidation

The results on oxidation of lignin are rather disappointing in so far as throwing any light on the structure of the substance is concerned. When lignin is oxidized even under mildest conditions, complete disruption of the molecule takes place and very simple degradation products are obtained. By the action of ozone, only formic and oxalic acids were obtained by König. With alkaline H_2O_2 and $KMnO_4$, simple aliphatic acids such as formic, acetic, oxalic, succinic and malonic acids were obtained. By the so-called "pressure oxidation" (heating with 1.25 N NaOH, under 55 atmosphere pressure at 200°) a variety of acids including benzene carbooxylic acids have been obtained by Fischer, Schrader, and Friedrich. It is impossible to account for their formation from the knowledge we now possess about lignin, it is still more absurd to fit them into any formula. Many have allowed a very high discount for these results, however interesting they might appear at first sight, owing to the drastic method that was employed.

Oxidation of methylated lignin by $KMnO_4$ followed the same course as of ordinary lignin, same products being obtained. Pauly and Feuerstein in 1929 applied for a patent for the preparation of vanillin by the oxidation of lignin with ozone in presence of glacial acetic acid. I do not know if any firm is making vanillin thus.

With ClO_2 *lignin* gives water saluble *aliphater* acids as with nitric acid. We have isolated a chloro-lignin which is first formed when ClO_2 acts on lignin—the Cl_2 *coming in all probability from the* oxidation of HCl which is always formed whenever ClO_2 acts on an organic compound. Schmidt obtained 34·8% *maleic* acid by *oxidizing* lignin with ClO_2.

Phillips and Goss obtained anisic acid by oxidizing lignin with 5N HNO_3 after methylation. From ethylated lignin they got p-ethoxy benzoic acid. -C-<=>OH group, they say, is present in lignin. This work however requires confirmation, as a free phenolic group has to be provided for in this case which goes against other observed facts.

Reduction

Ordinary reducing agents are without any action on lignin. Drastic methods of reduction up till now failed to give any clue as to the constitution of lignin. Willstätter and Kalb heated HCl-lignin with HI and red P at 250°, and obtained a mixture of hydrocarbons besides some products of acidic nature. No definite compound they could isolate therefrom. Mixtures of hydrocarbons of the same general composition were obtained by the reduction of cellulose, glucose and other carbohydrates. This, according to these workers, indicates that a close structural relationship exists between lignin and the carbohydrates. It is doubtful whether any such definite conclusion is justified in view of the drastic method employed and the doutfut nature of the compounds obtained.

Catalytic hydrogenation under pressure (250 atm.) with nickel also failed to give any hopeful result. A mixture of phenols and neutral substances were obtained by many. No definite organic compound was isolated.

Lignin was also distilled with Zn dust in an atmosphere of H_2—none of the fractions obtained was oxygen free, nor were they homogeneous. Phillips claims to have isolated catechol adopting the same procedure, as well as guiacol and anisic acid. But in view of the fact that *no* other worker could separate any such thing, these results must be accepted with a grain of salt.

It is noteworthy that with different samples of lignin different workers succeeded in getting the same troublesome mixture refusing to part with any of its constituents.

Hydrolysis

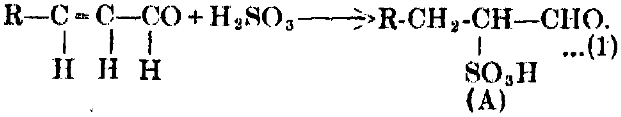
Lignin is remarkably resistant to ordinary hydrolyzing agents both acid and alkaline. Even under pressure and high temperature hydrolysis is but incomplete—no definite compound having been isolated as yet. Heuser and co-workers heated lignin in a sealed tube with HCl upto 170°-80° and found that complete de-methylation resulted. But the product could not again be methylated to its former methoxyl value. We have already seen how Hägglund got arabinose by boiling lignin with 3% HCl and how his hypothesis has been rejected by all others. By acid distillation—which is surely hydrolytic, HCHO has been obtained by Freudenberg and Harder. We have already discussed its significance in connection with the O-CH_2-O group in lignin. By heating lignin under pressure of 10 atmospheres with 4% KOH, according to Mehta, we have obtained only a water-soluble product, deep brown in colour, with many of the characteristics of lignin lost. Barium lignosulphate heated with baryta gave a tannin like product, which could not be identified. We find that hydrolysis of jute lignin with 12% HCl gave CO_2 which in all probability comes from a COOH group. The distillate with acid or preferably alkali, gave iodoform with iodine and alkali, which suggests a CH_3-CO, or CH_3-CHOH group in lignin. The volatile product could not be identified but it appears to be a neutral body, but not ethyl alcohol or acetone. Even in the cold, jute lignin responds to this iodoform test. Thus, it is clear that in determining the constitution of lignin, hydrolytic processes can help us but little.

Distillation

A arge group of workers, including Heuser, Pictet Fischer, and others have subjected lignin to dry distillation. A tarry product, mainly carbon residue, results in prepondering amount. Very small quantities of acetic acid, acetone and methanol were obtained. Phenolic compounds have been obtained by Tropsch, Phillips, and Pictet in the oily distillate the percentage of which is pretty high, being about 37%. Pictet and Gaulis got some very interesting results. They obtained 15% oil, 21% aquous distillate and 52% carbon residue. Eugenol was detected in the oily fraction. This, according to these workers, indicates that lignin contains the grouping of coniferyl alcohol. They separated the alkali-insoluble fraction by liquid SO_2 into two saturated and unsaturated hydrocarbons—$C_{13}H_{26}$, to $C_{30}H_{60}$, in the saturated porotin and $C_{11}H_{16}$ to $C_{13}H_{16}$ in the saturated one. Some of these are known to be present in petroleum. Pictet and Gaulis believe that lignin tar and coaltar are closely alike and support the hypothesis of Fischer that coal originated not from cellulose but from lignin. We are led to this conclusion by the fact that biological decomposition of cellulose takes place far more rapidly than that of lignin. Their results also indicate, they hold, that there exists a hydroaromatic ring in lignin. Owing to the drastic nature of the method employed, it may not be safe to draw this conclusion from these experiments alone. Of the phenolic compounds, Phillips isolated from the oily fraction—catechol, phenol, o-cresol, guaicol, cresol and three methioxylated benzene compounds with OH or COOH groups. The steam-volatile neutral fraction of the oil, when oxidized with $KMnO_4$ gave anisic acid and in the non-volatile fraction, n-nonacosane was identified.

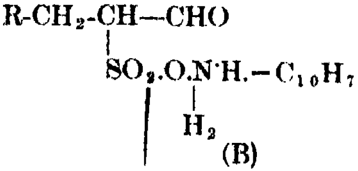
Ligno-sulphonic acids

In the manufacture of paper pulp and other cellulose preparations, where lignin is an undesirable element, wood and similar lignified materials are heated with a solution of sulphurous acid and acid sulphites, the lignin goes into solution, leaving the cellulose in a more or less pure form. The solution containing lignin, the sulphite-liquor from pulp mills, contains ligno-sulphonic acid, in the form of a Ca salt. Many attempts have been made by several investigators, Klason being most noteworthy, to separate it into pure forms but in vain. No definite compound has yet been isolated therefrom, although Klason claims to have separated two fractions, α- and β-lignosulphonic acids, the former precipitated with $CaCl_2$ from the solution of the sulphite liquor, the latter remaining in solution. Separation into α and β has been subsequently effected by β-naphthylamine hydrochloride when the β-naphthylamine precipitate was warmed with dilute alkali, it was found that only a part of the β-naphthylamine could be split out. Klason explained it as follows assuming that α-lignosulphonic acid contains an aromatic grouping :

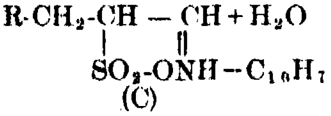


$$\underset{\mathrm{H}}{\mathrm{R{-}C}}{=}\underset{\mathrm{H}}{\mathrm{C}}{-}\underset{\mathrm{H}}{\mathrm{CO}}+H_2SO_3 \longrightarrow \mathrm{R{-}CH_2{-}}\underset{\underset{(A)}{SO_3H}}{\mathrm{CH}}{-}\mathrm{CHO.} \quad \ldots(1)$$

(A) treated with β-naphthyl amine gives the normal salt (B) as a white precipitate. By a secondary reaction (C) is formed :

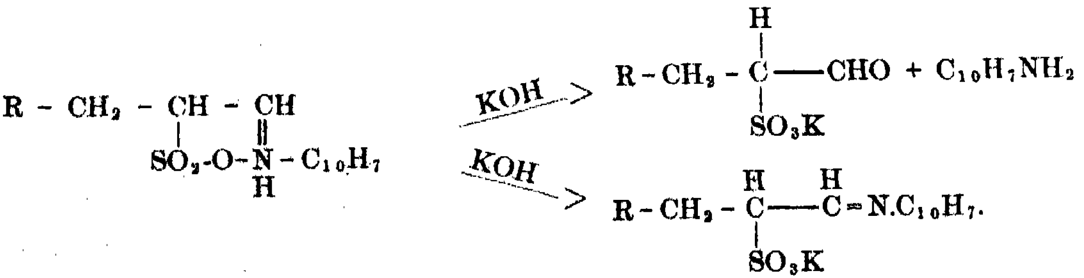


$$\mathrm{R{-}CH_2{-}}\underset{\underset{\underset{(B)}{H_2}}{SO_2.O.NH.-C_{10}H_7}}{\mathrm{CH}}{-}\mathrm{CHO}$$



$$\mathrm{R{-}CH_2{-}}\underset{\underset{(C)}{SO_2{-}ONH-C_{10}H_7}}{\mathrm{CH}} - \mathrm{CH} + H_2O$$

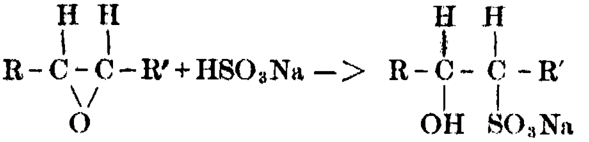
When (C) is treated with alkali, the reaction proceeds in two ways :



$$\mathrm{R - CH_2 - }\underset{SO_2\text{-}O\text{-}\underset{H}{N}-C_{10}H_7}{\mathrm{CH}} - \mathrm{CH} \begin{cases} \xrightarrow{KOH} \mathrm{R - CH_2 - }\overset{H}{\underset{SO_3K}{\mathrm{C}}}\mathrm{—CHO} + C_{10}H_7NH_2 \\ \xrightarrow{KOH} \mathrm{R - CH_2 - }\overset{H}{\underset{SO_3K}{\mathrm{C}}}\mathrm{—}\overset{H}{\mathrm{C}}{=}\mathrm{N.C_{10}H_7.} \end{cases}$$

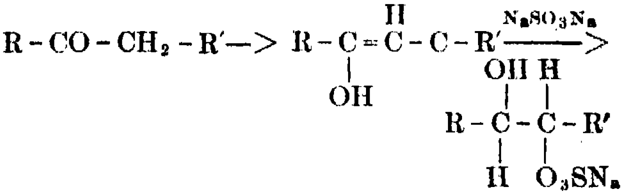
Of the total lignosulphonic acid about ⅔ was found as α- and ⅓ as β-acid. According to Klason, β-lignosulphonic acid contains an acrylic acid group. Hintikka questions however whether an acrolein group is present in lignin.

Freudenberg holds that it is quite unnecessary to assume, as Klason does, the ethylene linkage, for which experimental facts are lacking, to explain the formation of rather stable lignosulphonic acid. He says that the sulphur acid group is substituted in the benzene ring. Hägglund explains the formation of lignosulphonic acid thus :



$$\mathrm{R-}\overset{H}{\mathrm{C}}\mathrm{-}\overset{H}{\mathrm{C}}\mathrm{-R'} \,(\text{C–C bridged by O}) + HSO_3Na \longrightarrow \mathrm{R-}\overset{H}{\underset{OH}{\mathrm{C}}}\mathrm{-}\overset{H}{\underset{SO_3Na}{\mathrm{C}}}\mathrm{-R'}$$

to account for the appearance of a OH group for every unit of the lignin molecule containing 2 OCH_3 and 2 OH groups. Alternative to above a keto enol change might also occur :



$$\mathrm{R-CO-CH_2-R'} \longrightarrow \mathrm{R-}\underset{OH}{\mathrm{C}}{=}\overset{H}{\mathrm{C}}\mathrm{-C-R'} \xrightarrow{N_aSO_3N_a} \mathrm{R-}\overset{OH}{\underset{H}{\mathrm{C}}}\mathrm{-}\overset{H}{\underset{O_3SN_a}{\mathrm{C}}}\mathrm{-R'}$$

Chlorination

Lignin, isolated or not, can be very readily chlorinated by free Cl_2, bromination is effected with some difficulty, iodination, directly or indirectly, has not yet been done. Except Hibbert and Sankey, all consider halogenation of lignin as a process of substitution rather than of addition. We have already discussed the question of double bond from this point of view. Cross and Bevan, the pioneer workers in lignin, worked with jute and separated lignin as 'lignone chloride' and ascribed the simple formula $C_{19}H_{18}Cl_4O_9$ to it. We shall see later on how it is no longer tenable.

A large volume of work has been done on chloro-lignin but the same sad inconsistency prevails all through, hardly two workers agree regarding their chloro-derivatives in respect of Cl-content and other properties. The main factor in this case perhaps has been that very few of them have worked under identical conditions and tried to eliminate the factors leading to partial degradation of the lignin derivatives. In any case, we have been forced to reject practically all the important conclusions of Cross and Bevan from their chlorination data regarding the structure of lignin. None else could obtain mairogallol in leucogallol from the sublimation of lignone chloride. The ketonic formula must go.

Under similar conditions we have been able to obtain a chlorolignin from jute and from separated lignin always with the same percentage of Cl and also having the same properties. A portion of the OCH_3 group is always lost during chlorination and bromination of lignin, as also with vanillin. The $O\text{-}CH_2\text{-}O$ group as well suffers decomposition. Chlorination in presence of water is always attended with oxidation and a product is obtained which is partly soluble in water. The maximum chlorine content at room temperature has been 25.78%, at 60°, as with catalysts like I, $FeCl_3$ or antimony trichloride, 17.6%, on re-chlorination of the first product (25.8%) a derivative with 32.7% of Cl is obtained. When heated upto 135°-40°, HCl evolves from Cl-lignin, and a product with 17.8% is left behind. Dissolved in dilute alkali and precipitated with acids, a product with 17.70% of Cl is obtained. These facts can be satisfactorily explained by taking the molecular weight of jute lignin as 816. 25.86% of Cl means 8Cl atoms in the molecule, $C_xH_{y-8}Cl_8O_z$, on being heated to 135°—40°, or treated with alkali in the cold, 3 atoms of Cl are lost as HCl and we are left with $C_xH_{y-11}Cl_8O_z$ with 17.7% of Cl. During chlorination at 60° or with catalysts the same product results. On re-chlorination, we get a compound with 11 atoms of Cl, $C_xH_{y-11}Cl_{11}O_z$, with 32.7% of Cl. The Cl-lignin (obtained at room temperature) has a OCH_3 value of 5.61%, which means $2CH_3$ groups are present. The molecular weight in phenol of Cl-lignin with 25.8% of Cl has been found to be 1080 by the cryoscopic method, the theoretical value being 1090. By B. P. method Waentig obtained a similar figure for Cl-lignin from straw.

Clorolignin, just like chlorophenol, is more resistant to ClO_2 than lignin itself, which shows that some of the Cl-atoms have entered the benzene rings in lignin. Secondly, the fact that HCl is evolved on solution in KOH or by heating tends to show that Cl also enters the side chain as well, for Cl in the ring never behaves like that.

It may be noted here that absolutely dry jute can be chlorinated by dry Cl, in CCl_4 suspension, and so the argument that the oxidizing action of moist chlorine is required to disrupt the union between cellulose and lignin cannot stand.

Basic Composition of Lignin

From a careful study of the literature on lignin, it would appear that all lignins have the same basic composition. It is highly improbable, if not absurd, that there are as many lignins as there are ligno-celluloses in the world—there being innumerable types of wood. Powell and Whittaker made a thorough study of seven different wood lignins and from their analytical data put forth $C_{41}H_{40}O_{16}$ as the hypothetical mother substance for all of them. This has not been able to explain good many facts of fundamental nature and so has been practically rejected. But that all lignins have the same basic composition will be evident from the following :

(*i*) The decomposition products of all lignins on potash fusion are the same *viz.* oxalic acid, protocatechuic acid, pyrocatechol etc though the yield of these has not been the same.

(*ii*) By the action of HNO_3, it gives oxalic acid and a nitro-body of variable composition.

(*iii*) By chlorination, a chloroderivative is obtained, whose physical and chemical properties are similar. The percentage of Cl_2 varies owing perhaps to different techniques followed.

(*iv*) The same constituent groups are always found in all samples of lignin : OH, OCH_3, $-O-CH_2-O-$, iodoform-yielding complex, etc.

Aromatic Nature of Lignin

There is considerable difference of opinion amongst workers on lignin, as to whether it is aliphatic, aromatic or heterocyclic. An overwhelming majority of experimental evidences obtained in the course of the last two decades, shows that lignin contains the benzene nucleus. Apart from the results of chemical examination of lignin, we have in our support the physical data obtained by Herzog and Hillmer and others from the study of the ultraviolet absorption spectra which indicate a benzenoid structure for lignin. The following arguments are in favour of an aromatic structure of lignin :

(*i*) The formation of protocatechuic acid and pyrocatechol on potash fusion of lignin can be explained.

(*ii*) Lignin, insoluble in caustic alkalis, dissolve readily in them when the HCHO is split off, which shows that free phenolic groups have been set free.

(*iii*) Reducing action of the lignin from which HCHO has been removed and also the failure of pure lignin to reduce Fehling's solution can be properly accounted for.

(*iv*) Unlike aliphatic compounds, aromatic ones are more or less susceptible to the action of ClO_2. Lignin is readily acted upon by ClO_2 as also phenolic compounds. Cl-lignin is attacked less readily just like Cl- or Br-phenols. This will indicate that, on halogenation, the Cl or Br enters at least partly the benzene ring.

(*v*) OCH_3 groups are split off, at 92°--93°, from lignin, at which temperature, vanillin, vanillic acid etc., also part with their CH_3I in Zeisel's method of estimation of OCH_3 groups. Also, as pointed out by Freudenberg, the CH_3O groups are split off more slowly from the aromatic compounds and the rate of removal of OCH_3 from lignin agreed with that of vanillin etc.

Indirect evidences, against the carbohydrate or aliphatic structure :

(*i*) ClO_2 does not decompose sugars.

(*ii*) The amount of oxalic acid by HNO_3 oxidation is less than theoretical and even that is derived from the breaking down of protocatechuic acid and pyrocatechol.

(*iii*) No furfural or its derivative is obtained from lignin.

(*iv*) Delignified jute or other celluloses fail to give any aromatic product on potash fusion.

(*v*) No sugar has yet been isolated from the decomposition products of lignin except galactose by Rassow and Linde alone, which we may not accept as derived from lignin itself,

Molecular Structure of Lignin

Until recently, workers in the field of lignin chemistry were practically unanimous regarding the molecular size of lignin. Its molecular weight was considered to be near about 800. Experimental data on molecular weight determination supported this view (Fuchs, *Chemie des Lignins, p. 178*). As a matter of fact, many of the analytical results can be explained on this basis. Freudenberg and Hess explained the methylation of pine-wood lignin with diazomethane, taking 820 as the molecular weight of lignin. Fuchs and Horn from their analytical figures on acetylated pine-wood lignin arrived at the value 804. Klason studied the lignosulphonic acid from spruce wood and determined the molecular weight of the original lignin as 714.

Freudenberg (*Cell. chem.* 263, 1931) seems to be the first to express the opinion later on that lignin has a high molecular weight *viz.* 2176. His conception appears to depend primarily on the small yield of HCHO (1·2%) obtained from pine-wood lignin prepared according to his method. Klason, too, very recently has changed his former view and holds that the molecular weight of lignin must at least be 3640 (*Ber*, 302, 1934). But save and except these two veteran workers, others generally hold that the molecular weight of lignin cannot be higher than 900. (Brauns and Hibbert, Rassow and Wagner etc).

The method of potash fusion being too drastic, quantitative yield of aromatic products cannot be expected even when thh fusion is done under the mildest and most favourable conditions. Hence potash fusion data can furnish no definite information as regards its molecular size. But the highest yield of HCHO from jute lignin has been 2·78%. On the assumption that this represents 77·6% of theory (as with piperonylic acid) and also that one O-CH_2-O group is present in lignin, its molecular weight comes to 830, which is in fair agreement with those obtained by others. Very recently Harris *et al* have found 1·6% of HCHO in maplewood lignin, it is not mentioned whether they took all possible precautions to prevent the loss of HCHO during isolation.

The molecular weight of Cl-lignin from jute has been found in phenol to be 1080, from which the molecular weight of lignin comes to be 816. The mechanism of chlorination has been satisfactorily explained on this basis. Waentig determined the molecular weight of Cl-lignin from straw and obtained a similar figure. 19·18% of OCH_3 in pure lignin from jute means 5 OCH_3 groups in 830, 34·51% OCH_3 in the methylated product means 5 OCH_3 groups have entered the molecule of 830.

29.45% acetic acid from the acetylated jute lignin means 5 acetyl group entering the molecule of 830. The methylation and acetylation data agree strikingly well.

The above review will clearly indicate that inspite of our best efforts the problem is yet unsolved. The mechanism of the formation of cellulose and lignin might throw a flood of light on this intricate problem but no definite information has been obtained in this direction as well. The two processes—an alytical and synthetic—must be followed far more carefully than has hitherto been done and this might be effected by a future genius—a Baeyer or a Fischer—for whom we are waiting.

BERYLLIUM-COPPER ALLOYS

Beryllium, the rare element contained in the gem stones, emerald and beryl, is now produced in commercail quantities and used for imparting valuable properties to copper alloys. These alloys, containing only about 2 percent of this rare metal, have rapidly developed to great commercial usefulness. In summarizing developments in this field, Horace F. Silliman recently made the following statements.

"In many cases beryllium-copper has been substituted for other copper alloys and for steel, even though it is relatively more expensive than the older alloys. The wrought alloy goes into the manufacture of springs and other articles having spring parts. Springs made from this alloy have the corrosion resistance of copper plus high resistance to fatigue, high resilience, and low hysteresis loss. In addition to coiled springs and the flat springs, the list of spring-like parts includes diaphragms, fuse clips, current-carrying contact springs, spring washers, switch blades, and many other articles. The alloys are particularly adapted for instrument parts because they are non-magnetic.

"The comparatively high hardness and shock resistance of beryllium-copper permits it to be used for non-sparking hand tools such as hammers, chisels, wrenches, wrecking bars, drift pins, scrapers, and the like, and for pistons in vibrators and firing pins in firearms. The good wear resistance is advantageous in precision bearings, bushings, ball cages, adjustable-pitch propeller hub cones, gears, and sliding contacts. Other commercial uses at present are platers' bars and cores, retractable landing-gear parts, surgical instrument handles, woven wire cloth, bolts and nuts, molds for plastics, and valve parts.

"In about four years these remarkable alloys of one of the oldest and one of the newest of the metals used by man have assumed considerable commercial importance."—*Scientific American.*

The Irvine Committee Report and After

In a previous issue (Vol. II No. 8) we had occasion to deal at some length with the second Quinquennial Reviewing Committee (also known as the Irvine Committee) on the work of the Indian Institute of Science, Bangalore. We had also referred briefly to the recommendation of the Committee and their significance in relation to the unusual problems at issue. In this connexion the following observations on the post-Irvine-Committee happening at Bangalore by an observer on the spot will prove interesting to our readers.

The proposals of the Committee have been accepted by the Governing Council of the Institute. His Excellency the Visitor has already given his general assent to the proposals and has agreed to the appointment of the Registrar who will take over the administrative duties now discharged by the Director. The appointment has already been made (though the incumbent has not yet joined). The unfortunate developments of the past few months have raised an increasingly difficult situation which offers no very easy solution.

In one of the concluding paragraphs of their report the Irvine Committee state :

> "It may be the case that our proposals are a compromise, forced upon us by circumstances but nevertheless we believe that they represent a workable solution of existing difficulties. If given a fair trial and if operated in the right spirit, they will enable the Institute to begin its second semi-Jubilee period with renewed hope. If our scheme fails it can only be through clash of personalities beyond the remedy of any powers possessed by a Reviewing Committee."

These words, ominous in a way, have, according to the information received by us, proved prophetic and the human problem is more acute today than ever before.

It was reported in the daily press that at their meeting held in August 1936 the Council of the Institute appointed a Special Committee to investigate amongst other things the various memoranda submitted by the professors and the other members of the staff complaining of the unconstitutional methods adopted by the Director and the unfair treatments meted out to them and their departments. The Committee held a number of sittings in November 1936 and in January 1937. They went very carefully into all the materials placed before them and critically examined a number of witnesses who appeared before them to tender oral evidence.

The report of the Committee has not yet been published but their conclusions are generally well known through information leaking to the daily press, which has not been contradicted. It is alleged that the Committee found ample evidence to support the complaints made by the professors, and the Senate—who are entrusted with the responsible task of going into the teaching and research—have been mostly ignored by the Director, and even the legitimate requests for meetings to discuss important matters were not complied with. Instances of failure to comply with the regulation and by-laws were not wanting.

The findings of the Reviewing Committee in regard to the efficiency of the present administration are well known. If, added to that, the Council finds that even after the adoption of the new regulations matters do not improve but get worse with the times, the duty of the Council and of the Government is fairly obvious. Personal considerations should in no way interfere with the administration of justice.

With such an unpleasant situation brewing at almost the very next door, it is rather surprising to find our Bangalore contemporary, *Current Science*, making such an elaborate attempt to pick holes in the Irvine Committee report and indirectly upholding the present administration. The tone and the spirit of the two editorials which appeared in the January and February issues of *Current Science* are too obvious to be mistaken.

One of the most extraordinary arguments adduced by our contemporary is that the Committee strayed beyond the terms of reference. They would have produced a more valuable report if they had treated the Institute from an impersonal standpoint. In the first place, it may be pointed out that the terms of reference even as cited by our contemporary, *viz.*,

> "To review the working of the Institute with special reference to the purpose for which it was founded, and if any changes are considered desirable in the organization or activities of the Institute for the better achievement of this purpose, to make recommendations accordingly with due regard to the Institute's actual or reasonably augmentable financial resources,"

do permit of the investigation of all the factors relating to the working of the Institute. Secondly, it may be reasonably argued whether an expert Committee of that composition would not have encroached on delicate and difficult personal questions if they were not quite sure of their composition. Thirdly, neither the Governing Council of the Institute nor the Government of India—the chief authorities concerned—have questioned the scope of the enquiry. They have, in fact, welcomed the report in all its aspects and they have taken steps to implement the recommendations of the Committee. With such facts before them, it is rather surprising that our contemporary did not even concede the benefit of doubt when questioning the scope of the enquiry.

In the pursuit of science as in other walks of life, human association is of the greatest importance. Friendly relationship between fellow workers, mutual sympathy and support in matters of every day life, and active co-operation and even colaboration in the investigation of the more important scientific problems are considered essential for the success of any big organization. Compliance with recognized course of conduct and obedience to rules and regulations are also necessary for smooth and efficient working. Failure to observe these, combined with callous disregard for the feelings of one's colleagues and a tendency to aggression, is bound to lead to clash of personalities. If, added to these, there is evidence of unsound judgment, of personal prejudices influencing adjudication of technical matter and adoption of questionable methods to gain certain immediate ends, then, as revealed in the Irvine Committee's report, there will be opposition from every right-thinking man. Even the Governing Council of the Institute—as admitted by our contemporary—should have been well within their rights to check such a defective administration, but to argue that the Reviewing Committee were not justified in referring to the most important problems which were placed before them would be highly fallacious and even unfair tot he Institution. As it is, the authorities of the Institute and the public of the country owe a deep debt of gratitude to the Committee for having so courageously voiced their views on the points at issue and made such valuable suggestions.

Another faulty argument adduced by our contemporary is that as the aggregate income for the past seven years had exceeded the corresponding expenditure, there is no evidence of deficit. That would be like arguing that the seven "fat" years compensate for the seven "lean" years so that there was no evidence of famine in Egypt! What the Committee have endeavoured to show—and what will appeal to every thinking individual—is that in recent years the annual expenditure has considerably exceeded the corresponding income so that the institution has been obliged to draw on its reserves. As the reserves now bear interest and thus contribute partly to the income of the Institute, withdrawal of deposits will further reduce the income, with consequent enhancement in financial bankruptcy. The Committee have recommended, therefore, that the budget should be balanced from year to year and that excess of expenditure over income should under no conditions be allowed. Surely there is nothing wrong with such a proposal !

Our contemporary has obviously been at great pains to discover weak points in the report. The Committee's inadvertent recommendation to abolish the post of Warden (mistaking it for that of the Steward) is pardonable or at ony rate can be easily set right. The lengthy arguments to show that the Committee were not justified in laying so much emphasis do not in any way affect the report, because it is essentially a matter of opinion. Indeed, there is a strong section, both in this country and elsewhere, who would hold that pursuit of purely academic enquiries—though capable of yielding results of far-reaching importance—will not be of any direct assistance to industries. The work will lack the necessary technical outlook and cannot contribute so usefully as those with an applied bias. India is badly in need of technical men with the necessary works experience, and unless such men are turned out in sufficiently large numbers, there is not much prospect of any industrial development in the country.

The last argument regarding the effect of curtailment of grants on the scientific output is the strongest of all. It is well known that scientific research—especially in chemistry and engineering —takes some time for completion. Several months —sometimes even a few years—must elapse before a piece of work can be completed. Even then one is not satisfied. Portions will have to be repeated and the observations checked under new set of conditions. The subsequent writing up in a publishable form is no easy task : it is a nightmare to most workers. Publication especially in European or American journals is a very slow process, delay of several months (one year and more) being not uncommon. Even granting that all the above mentioned processes are completed in minimum time, it is not physically possible to ordinarily commence and publish a work in the same year. A conservative estimate would show that not less than two years—often three or more—would be required for that purpose.

If these facts are taken into consideration, it will be readily seen that most of the researches published during 1934-35 (the year of reduction of staff and curtailment of grants) should have belonged to an earlier period, probably 1932-33. The effects of the curtailment would be seen in a later period and would more appropriately come within the purview of the next Quinquennial Reviewing Committee.

A careful study of the report will show how the present conditions have tended to affect the working particularly of the chemistry and engineering departments.

"As we read the situation (and there is ample uniformity in the evidence), the Director's policy is to make the Institute a centre for Physical and Mathematical studies. True, there has been no suggestion that other departments should be suppressed, but as time goes on, they will eventually become more and more subordinate to Physics, until their individuality is to all intents and purposes extinguished. One example of this tendency which may be quoted and it does not stand alone is the transference of apparatus from the Department of General Chemistry to the Department of Physics, where certain researches are now grouped under the heading Chemical Physics. Other cases have been reported to us, in which the transference of equipment was made against the wishes of the staff and under conditions which inevitably gave rise to bitterness and dissension."

"The Department of General Chemistry, lacking the experience and guidance of a professor, with repleted staff, reduced grants for equipment and few admissions, now occupies an undistinguished position in the Institute. A course of chemical engineering with special reference to sugar technology was instituted in 1933 and a part-time lecturer was appointed for that purpose ; there was a large demand for admissions to this course ; but the admissions have now been stopped. The course, excellent in intention, is being extinguished through lack of suitable staff and want of official encouragement".

"Not only is Physical Chemistry threatened with extinction but the future of the Organic Chemistry is likewise in jeopardy, if recent decisions of the Council are carried into effect".

THE IRVINE COMMITTEE REPORT AND AFTER

The staff of the Department of Electrical Technology has been reduced, grades have been lowered; there have also been frequent changes.

> "We have thought it necessary to record these staff changes in some details, because we are of the opinion that the present feeling of instability in this Department—a feeling which has been given full expression in the evidence before us—is in no small measure due to the frequent alteration of personnel. There can be little continuity in the work of a department whose staff undergo such constant changes and we hope that our recommendations will remove the personal feeling of insecurity and ensure greater permanence among the staff".

These

> "have revealed a disquieting state of affairs and it is our considered opinion that unless firm action is taken at once, the future of the Institute is exceedingly precarious"

> "If the present conditions are permitted to continue, it will be no easy matter to find men of character and independence to fill future vacancies." "Under the present conditions our recommendations become more emphatic in order that the Institute may be saved from disintegration".

What more proof is needed to reveal the alarming state of affairs at Bangalore! It is indeed a marvel that the Institute managed to survive and preserve at least some scientific activity in the highly depressing conditions of the past few years.

In the concluding part of the second editorial under reference, our contemporary has voiced some noble sentiments with apt quotations which would otherwise be lost to posterity. Even to a casual reader of the report, the significance of this is obvious. It is indeed no wonder that even believing in such eloquent terms for "truth" and "strength of character" our contemporary should have dismissed the most important recommendations of the Committee as being "puzzling".

The Indian Institute of Science is an important national institution, and its future is of the greatest interest to every well-wisher of the country. It is of the utmost importance therefore that the present troubles should be rooted out and that a new era of harmonious working should be introduced without the least delay. In this connection, the question arises: Are the recommendations of the Irvine Committee sufficiently far-reaching to produce the desired result? Will every one forget and forgive, settle down to a new set of conditions and be happy ever after? Our knowledge of human nature leaves us very sceptical of the prospects about the future. In spite of aged experience there is no fundamental change in one's composition, and it is most unreasonable to expect that the proposed administrative changes will improve the conditions in the Institute. Further evidence to acute troubles has already been adduced by the Special Sub-Committee of the Council and the only way to deal with the problem is to remove one or the other of the clashing interests. If such a drastic action is contemplated will it be adequate—let alone equitable—to remove all the senior members of the staff and leave the Director in full and free administrative charge? Will the Director get on well with the new staff? The chances are that the past experience will repeat itself. There will be fresh quarrels and new issues and probably worse confusion resulting from them. The Institute has already suffered enough and cannot possibly stand a fresh shock. Then what is to be the solution?

Notes and News

International Congress of Philosophy

It is reported in *Science* (of Paris) of December 15, 1936, that the Ninth International Congress of Philosophy (to be otherwise known as Descartes Congress) will be held in Paris during the first week of August 1937 to celebrate the tercentenary of the publication of *Discours de la Méthode* of Descartes, the celebrated French philosopher.

The discussions that are expected to be held on this occasion will be confined to the following topics:

(1) The present state of Cartesian studies.
(2) Unity of Science: the method and the methods—its history and its present state.
(3) Logic and Mathematics.
(4) Causality and Determinism in Physics and Biology—Probability and Statistics.
(5) Reflexive Analysis and Transcendence. Idea of Soul—Body and Soul—Soul and God.
(6) Value, Norms (logical, moral, juridical and esthetical) and Reality.

Cheap Electricity for Calcutta

We have repeatedly drawn the attention of the reader in these columns to the advisability and necessity of a reduction of the electric charges by the Calcutta Electric Supply Corporation. We have also shown in some detail how unjust it is for the Corporation which having the monopoly of supply in Calcutta is safe against all competition, to continue to charge the public for the supply of electricity at an inordinately high rate. The cost of coal and the cost of labour being the cheapest in Calcutta and that of machinery, etc, being practically constant, there is absolutely no reason why the unit of electrical energy should not be cheaper than the rate prevailing in other countries. Persistent public agitation, through the press and on platform, led the Government to appoint in 1935 an enquiry committee with a view to reduce the electric charges but the findings of the committee were utterly disappointing, and the reductions recommended were not commensurate with the financial position of the Company and there was ample scope for further reduction up to at least *one anna* per unit for lights and fans, as indeed maintained by Dr B. N. Dey, Chief Engineer to the Calcutta Corporation, who in course of his report regarding schemes to secure supply of electricity at the cheapest possible rate, says (*vide The Calcutta Municipal Gazette*, 17th April, 1937, p. 698):

"The domestic rate of one anna per unit (for lights and fans) may be called a fairly cheap rate that is possible to be obtained under the present company-managed system. I reiterate my opinion that this rate of one anna per unit for lights and fans is a reasonable one as shown by my analysis of cost and my evidence before the Government Enquiry Committee. That Committee have recognized the possibility of further reduction below 2 annas per unit rate recommended by them."

Dr Dey, therefore, proposed among other proposals that the undertaking now operating the Calcutta License be purchased through an agency, who will run it as lessee to the Calcutta Corporation, guaranteeing one anna per unit (domestic rate) and other rates as proposed by the Calcutta Corporation. This proposal was adopted by the Public Utilities and Markets Committee of the Corporation on the 31st March last. We earnestly hope that it will receive all the attention it deserves by the authorities concerned.

Public Health Commissioner's Report for 1937

An account of the steps taken to combat disease and mortality in India is given in the Public Health Commissioner's report for 1934. Amongst other things, these steps include provision for the treatment of diseases, training in medical science and practice and researches to find out remedies.

Hospitals and Dispensaries: At the end of 1934, there were in British India 6597 hospitals and dispensaries, following the modern system of treatment: Madras—1,356, Bengal—1,310, the Punjab—969, B. & O.—690, U.P.—686, and Bombay—533. On an average, 41,800 persons were served by each of these institutions, the averages for rural and urban institutions being roughly 58,500 and 12,000 persons respectively. Of these institutions 5,202, or 79 per cent, were maintained either by Government or local authorities or both, and only a small number, *i.e.*, 545, or 8 per cent, were financed, managed or controlled by private organizations. Of the total nearly four thousand and a quarter were in rural areas and the rest in urban. In rural areas facilities for medical relief remain very inadequate, the small Province of Coorg standing out as the area in which rural medical relief is the most developed.

The number of beds available in all classes of institutions were nearly 72,000, of which 46,000 were for males and the rest for females. The number of patients treated were 75,500,000 of which 48,500,000 were males and the rest females. The low figures of females treated by no means connotes relative healthiness of the female population but is ascribable partly to the prevailing *purdah* system and partly to the inadequacy of indoor accommodation for females.

Facilities for the treatment of women exist in all classes of institutions, but the numbers of hospitals and dispensaries exclusively for women are not very many, those maintained or aided by Government or by local funds numbered 78 in the United Provinces, 41 in Madras, 40 in the Punjab, 14 in Bengal, 11 in the Central Provinces, 8 in Bombay, 5 each in "Bihar and Orissa" and Burma, and 4 in N.W.F.P. Of these 206 institutions, 30 were State-public, 99 local and municipal fund, 74 private-aided. These hospitals and dispensaries are mostly located in headquarters and other urban centres and some provide only outdoor treatment.

Income and Expenditure: The total income of hospitals classed as State-public, local and municipal fund, in private-aided, was during the year nearly Rs. 4,30,00,000, of which over Rs. 1¾ crores came from contributions made by Government and nearly Rs. 1½ crores from contributions by municipal and local funds.

The total expenditure on these institutions was nearly Rs. 3¾ crores, of which Rs 95¾ lakhs was on medical officers, Rs 36½ lakhs on nurses, Rs 30½ lakhs on diet, and Rs 49¼ lakhs on medicines.

Medical Personnel: The medical personnel in different Provinces during the year consisted of 179 I.M.S. officers, 90 Indian Medical Department Officers, 32 Women's Medical Service Officers, 1,750 salaried medical graduates, and 6,437 licenciates. The practice of associating selected private medical practitioners with the staffs of Government schools in an honorary capacity is gaining in popularity throughout the Provinces. In addition, newly qualified medical graduates and licenciates are being employed in increasing numbers as honorary surgeons and house surgeons in headquarters hospitals.

Nursing Services: During 1934, there were 3,697 nurses employed in hospitals, of which 3,486 worked in urban areas and 211 in rural. The nursing services in rural areas are developing very slowly. The total expenditure on nursing during the year in State-public, local and municipal fund and private-aided hospitals was Rs 35½ lakhs for nearly 11 lakhs of indoor patients, the expenditure on nursing per case treated being Rs 3-4-6.

Subsidized practitioners: Considerable progress has been made during the preceding decade in extending medical relief to remote rural tracts, notably in the Punjab and Madras, by means of subsidies to private practitioners.

Mental hospitals: The Census of 1931 places the number of insane persons in British India at nearly 98,000—60,000 males and 38,000 females. There were 19 mental hospitals for the housing of insane persons, which were maintained at a cost of Rs 35 lakhs during the year. These hospitals had accommodation for only 9,518 patients and could house during the year only 13,506 insane persons, of which nearly 10,500 were males and 3,000 females.

The apparent disparity between the incidence of insanity between males and females is stated to be attributable partly to the natural tendency to conceal female cases and partly to the fact that women, leading a more sheltered life, are less subject to anxiety and less liable than men to indulge in excesses of various kinds. Insanity is an affliction of the adult period, and an analysis of the total admissions into hospitals shows that 74 per cent were between 20 and 40 years of age, and nearly 60 per cent were Hindus and 21 per cent Muhammadan. The high incidence amongst females in these ages was evidently due to the strain of child-bearing; that among males corresponds to the period of entry into family life and the associated cares and worries.

Medical Education: There are 10 medical colleges in British India, of which Bengal, Bombay and Madras have 2 each, and the Punjab, Delhi, the United Provinces and Bihar and Orissa 1 each. The medical schools in existence in British India number 28 and are distributed as follows: Bengal 10, Madras 3, Bombay 5, U.P. 2, Punjab 2, B. & O. 2, Burma 1, C.P. 1, Assam 1, and C.I. 1. The Director-General, Indian Medical Service, in a note about these schools says that none of them have quite attained the desired standard and several are deplorably deficient, the two principal defects in most schools being overcrowding in the number of students and deficiencies in equipment.

Research: Important researches and medical investigations during the year were conducted at the Central Research Institute, Kasauli, the All-India Institute of Hygiene and Public Health, Calcutta, the School of Tropical Medicine, Calcutta, the Haffkine Institute, Bombay, the King Institute of Preventive Medicine, Madras, the Pasteur Institute of India, Kasauli, the Pasteur Institute of Southern India, Coonoor, the King Edward VII Memorial Pasteur Institute, Shillong, the Burma Pasteur Institute and Bacteriological Laboratory. During the year, roughly 600, 000 c.c. of prophylactic cholera, 350,000 c.c. of prophylactic T.A.B., 20,00 c.c. of prophylactic influenza vaccine, besides more than 10,000 doses of various other vaccines were issued from the Central Research Institute, Kasuali. The Institute also manufactured during the year nearly 6,000 tubes of antivenine, 14,000 tubes of normal horse serum, and 100 tubes of high titre (diagnostic) serum.

Indian Research Fund Association: In addition to the researches conducted at the Institutes named above, important investigations in malaria, plague, cholera, kala-azar, leprosy, nutrition, tuberculosis, vaccines and helminthology, besides numerous other enquiries were conducted under the aegis of the Indian Research Fund Association. The researches were of such far-reaching importance that it is difficult to pick out any in preference to others.

A large amount of material was collected for the study of post-epidemic conditions, endemic conditions and the effects of the Sukkur Barrage on the incidence of malaria.

Amongst the anti-malarial measures studied, there were Paris Green dusting in villages, use of larvicidal fish, destruction of larvae in streams and irrigation channels and relative values of spraying mixtures for killing adult mosquitoes. Investigations were also conducted into the relative clinical efficacy of totaquina as compared with quinine, the effect of climatic conditions upon the toxicity of plasmoquin, and new qualitative and quantitative tests were made for atebrin.

Experimental work was carried out on methods of testing the virulence of plague cultures and a standard test has now been devised. A study of the relative protective value of different plague vaccines was continued and the provisional conclusion was reached that the prophylactic administration of phage was effective in reducing the rate of attacks from cholera.

"Leprolin" was tried in the treatment of leprosy and in resistant cases with limited lesions it gave excellent results.

Investigations in nutrition included metabolic studies made to ascertain the extent to which cereal grains in common use in India favour or disfavour the retention of calcium, magnesium and phosphorous.

Amongst other enquiries mention may be made of the indigenous drugs and the drug addition enquiries by Lt.-Col. Chopra, which have been in progress for a number of years.

Medical Intelligence: An account of the organized activities to combat disease cannot be complete without mention of the steps taken to obtain medical intelligence and to keep out disease from coming in. The office of the Public Health Commissioner continued to function as the epidemiological bureau of the Government of India and issued epidemiological returns every week. India also actively participated in the activities of international health organizations such as the Office International d'Hygiene Publique, Paris, the Singapore Bureau, League of Nations, Health Section of the League of Nations, Geneva and the Congress of the Far Eastern Association of Tropical Medicines, held at Nanking, China, in October, 1934.

Steps were also taken in the Ports of Bombay, Karachi, Calcutta, Madras and Rangoon and Aden, to keep out diseases which might otherwise come in with travellers from abroad. For this purpose effective public health organizations were maintained at each of these Ports. Recently, it may be remembered, elaborate quarantine arrangements have been put in operation at the air port of Karachi so that persons travelling from Africa, which is the endemic home of Yellow Fever, may not carry the disease into India. Should Yellow Fever happen to be introduced into India, the disease would be so appalling, says the Public Health Commissioner, that it might well cripple the country for a generation. An idea of the magnitude of the danger with which India was faced may be had from the fact that not merely are all factors which make for a rapid spread of the disease are present but as a result of development of rapid aerial communication India is now only a few days distant in time from Africa and infected persons travelling by air from Africa can arrive in India well within the incubation period of the disease. Another danger is the possibility of infected mosquitoes being carried by air craft travelling direct from Africa to India and stringent precautions are now enforced to eliminate this danger as far as humanly possible.

Mr N. R. Sarker

Mr N. R. Sarker, the new Finance Member in the Ministry of Bengal, is well known to the outside world as a great financier and the head of one of the premier insurance concerns of Bengal. But people are not aware of one aspect of his activities in which SCIENCE & CULTURE is particularly interested. SCIENCE & CULTURE has in several articles pleaded for the establishment of a river physics laboratory in Bengal. In doing so it has only followed the lead of Mr Sarker. In 1927 the Government of Bengal under pressure from the all-powerful Bengal Chamber of Commerce had adopted a scheme for cutting a Grand Canal from the Ganges north of Calcutta to Khulna. This canal was to have cost Rs 8¼ crores and was to have provided a short-cut to Eastern Bengal for the benefit of the merchant princes of Calcutta. The welfare of the public and of the rural population did not form part of the scheme. The opening of such a canal was opposed to all hydraulic principles and would have, like the famous Burdwan and Ronaldshay dredgers, involved the Bengal Government into serious financial losses. The matter was taken up by Mr Sarker who was then a member of the Legislative Council and in several speeches and pamphlets he so thoroughly proved the unsoundness of the scheme that it was ultimately abandoned. By this public-spirited action, Mr Sarker saved Bengal from another financially ruinous scheme like the Bombay Backbay Scheme and the Mundy hydro-electric scheme. A perusal of this pamphlet showed that Mr Sarker has got a thorough grasp of the hydraulic problems of Bengal about which SCIENCE & CULTURE has published a number of well-informed articles by Dr N. K. Bose and Mr S. C. Majumdar. We have recently pleaded for the establishment of a river physics laboratory which will carry out fundamental research work on the hydraulic problems in Bengal and will yield results of great engineering importance for the lower Ganges valley. Now that Mr. Sarker is at the helm of affairs in Bengal, we may hope that he would be able to prevail upon his colleagues to take up the establishment of such a laboratory in near future.

Indian Cotton Scientists' Conference

An important conference of scientific research workers on cotton in India, the first of its kind in India, with a view to discuss many technical and scientific questions connected with the improvement of cotton from a purely scientific standpoint, was held in Bombay under the auspices of the Indian Central Committee on 4th, 5th and 6th March, 1937. The conference was presided over by Sir Bryce Burt, officiating vice-chairman of the Imperial Council of Agricultural Research and President of the Indian Central Cotton Committee, on the first day, and by Dr W. Burns, officiating Agricultural Expert, on the second and third day. The conference was attended by a large number of cotton research workers from all parts of India including junior cotton research workers, besides a number of professors from local colleges.

A number of papers on technology, mycology, plant breeding, agronomy and entomology were read and were followed by interesting discussion. An entertaining discussion took place on the inheritance of wilt resistance in cotton and it elicited a unanimous expression of opinion on the present state of our knowledge in this connexion and on the proper lines for scientific breeding of cottons against wilt resistance in future. The conference passed the following resolution:—

"This conference agrees that the breeding of strains immune to wilt under optimum conditions is the ideal to aim at. For agricultural distribution, resistance of the order of 95% under heavily infected field conditions is satisfactory, provided that the strain has been tested and shown to be practically homozygous for that degree of resistance to wilt.

The conference recommends that

(1) tests for homozygosity should be applied before a resistant strain is released for distribution,

(2) the Pathologist should also conduct test for homozygosity and need only select in material shown to be heterozygous, and

(3) the conditions under which field tests are being carried out should be described and standardized as far as is practicable."

The members of the conference availed themselves of their presence in Bombay by paying a visit to the Cotton Exchange at Sewri where they were shown the cotton standards used in survey and appeal and also the means for determining humidity in samples of cotton. They also visited the Technological Laboratory of the Indian Central Cotton Committee at Matunga, where Dr Nazir Ahmad and his colleagues showed the useful work being done at the institute. The conference devoted the third day of its sitting to the consideration of questions of plant breeding and statistics.

Poidih Colliery Disaster

One of the worst disasters in the history of Indian mining was the explosion in the Poidih colliery on the 18th of December, 1936, in which 209 persons (including manager), out of whom 68 were women, lost their lives. The explosion was so severe that no rescue work could be undertaken and the mine had to be sealed, as it was regarded to be improbable that anybody had survived. The colliery is about seven miles from Asansol. The Committee of Enquiry appointed to investigate into the causes and origin of the disaster consisted of Mr O. M. Martin (Chairman), Mr L. A. Jecobs, Mr B. K. Bose and Mr G. S. Cameron. They have recently submitted their report. The report says:

"As no explosives were used in the mine, it is extremely probable that the accident had its origin in the accidental ignition of an accumulation of inflammable gas rather than coal dust, but there is no definite evidence to show from what part of the mine the explosion originated, how it was propagated through the galleries or what was the igniting cause."

The following have been suggested as possible causes:

(i) A defect or an accidental damage to a safety lamp.

(ii) Misuse of a safety lamp in the presence of gas.

(iii) A light from a match or other apparatus for producing light.

(iv) A spark from electrical apparatus.

(v) A spark from some other accidental causes.

The Committee believe that there was not one explosion but a series of explosions following one another in quick seccession. A gas explosion followed by a coal dust explosion may have been followed again by another gas explosion. The committee also found that the manager had been deliberately falsifying attendance registers to conceal from the Government Inspectors the fact that he had been employing a far greater number of women inside the mine than the permissible limit of 8 p.c. It was also discovered that the mechanical ventilators which, when working, prevent the accumulation of inflammable gas, had been stopped for some time before the accident. The committee have made certain recommendations to minimize such accidents in future. In near future we hope to publish an authoritative article on mining accidents and their prevention, which we hope will interest our readers in view of the recent accidents in the Indian mines.

Bengal's Smaller Industries

A recently issued press note says that the Industrial Research Laboratory of the Industries Department of the Government of Bengal carries on systematic research work, in its chemical section, to assist the smaller industries which have not got the necessary resources themselves. It also helps such industries by solving minor technical problems, answering enquiries and preparing schemes. Among the subjects on which research work has been successfully done last year were the utilization of waste gas in the manufacture of silicate of soda, saponification by means of soda ash in soap making, soap making by the cold process purification of honey and the manufacture of metal polish. In addition to work which had not been completed last year (1935-36), it was proposed to carry on work on manufactures of varnishes, ink, sealing wax, disinfectants and sati-food.

Radio Research Board for India

Recently, in the Council of State, Pandit H. N. Kunzru moved a resolution to the effect that in view of the great importance of radio development in India, an all-India radio research board be established on the lines of the Radio Research Board of the United Kingdom. The resolution was rejected after some discussion in the course of which Mr A. G. Clow, on behalf of the Government, opposed the idea for lack of funds.

D.Sc. Awards

Nripendra Nath Chatterjee, formerly Sir Rashbehary Ghose research scholar in Chemistry, has been awarded the degree of Doctor of Science of the University of Calcutta, the subject of his thesis being "Syntheses of Phenanthrene Derivatives."

S. S. Banerjee of the Hindu University has been awarded the degree of Doctor of Science for his work on effects of bends and corners on the radiation resistance of parallel wire high-frequency transmission lines.

Industrial Research Grant

In a previous issue of SCIENCE & CULTURE (Vol. II, No. 9), we dealt at some length on the need of closer co-operation between universities and industries and the necessity for monetary grants by rich men, especially industrialists, of the country to stimulate and promote the growth of scientific research. There we mentioned the instance of Messrs Steel Brothers of London, who placed at the disposal of Professor S. S. Bhatnagar, head of the chemical laboratories of the Punjab University, a considerable sum for the facilities of his investigations. Scientific research in the Punjab is now further indebted to Dr Bhatnagar whose successful researches on industrial problems have brought forth a generous offer from Mr G. D. Birla. With the object of helping the University in taking part in the industrial development of the country Mr Birla, it is reported, has placed at the disposal of the Punjab University a sum of Rs 7,000 per year for a period of three years in order to enable Dr Bhatnagar and his researchers to undertake investigations on certain problems connected with the industries under the control of Birlas. Though a major part of the money was offered to him personally, Dr Bhatnagar made over the entire sum to his University, as he did with the grant of Messrs Steel Brothers. The syndicate of the University have accepted the offer as well as the scheme drawn up by Dr Bhatnagar for its utilization. We appreciate very much the generosity of Mr Birla as also the selfless devotion of Dr Bhatnagar to industrial research.

Science in Industry

The Proposed Steel Company at Hirapur

India has been importing annually, even on a conservative estimate, 300,000-400,000 tons of steel in excess of the output of the Tata Iron & Steel Company Ltd. Owing to the widespread industrial development of the country, however slow it may be at present, and the demands of iron in Europe and other foreign countries which are fast arming themselves heavily, it is but natural to expect that the future of the trade in iron is exceedingly bright in India as in other countries of the world. It is, therefore, quite in the fitness of things that Messrs Burn & Co., the managing agents of the Indian Iron and Steel Company Ltd., have recently announced the scheme of a new steel works at Hirapur (for the full scheme *vide Commercial Gazette* of the 2nd March 1937). It is held in authoritative circles that there is room enough for another big steel industry in this country to develop. According to the scheme the new factory to be started at Hirapur will turn out 2,00,000-25,00,000 tons of finished steel annually. Various facilities to the new company are proposed in the scheme by the managing agents of the Indian Iron and Steel Co. in return of one-fifth of the surplus profit. The arrangements proposed between the two sister companies are very satisfactory and the establishment of the new steel works at Hirapur seems to be a very sound industrial venture.

Mineral Resources of Singhbhum

"India's Northern Ontario" is the description given to Singhbhum, in a Memoir on mineral deposits of Eastern Singhbhum and surrounding areas, by Dr J. R. Dunn, published from the Geological Survey of India. One of the richest of India's mineral areas, it is the seat of India's major metallurgical industry at Jamshedpur and what will probably prove to be the world's largest deposits of iron ore, occur here and in adjacent areas. The mineral finds in the area are in fact of a diverse character, and include copper, apatite, gold, wolfram, mica, lead, iron-ore, vanadium-ore, manganese, chromite, asbestos, barytes, building materials, garnets, china clay, ochres, refractory materials, talc, road and railway ballast, and even platinum. At one time or another most of these minerals have been mined. Unfortunately, however, the minerals are rarely concentrated into payable deposits but lie scattered in the rocks, so that the area is not as rich as the diversity of the minerals found would suggest. Singhbhum has a copper belt over 80 miles in length with a history extending from the ancient days, 200 years ago down to the present times. The Memoir gives a description of each individual copper deposit as also of other deposits of importance such as iron-ore, apatite, gold and refractory materials, and for each deposit wherever possible Dr Dunn's explicit opinion of its economic value is given.

In the course of his report Dr Dunn says:

"Geology and mineralogy have now taken their place amongst the sciences studied in India, and the Indian School of Mines is fulfilling an important position in the mining industry. India does now possess the man with the requisite knowledge to undertake prospecting, but it seems that the work with its hardships possesses no special attractions. The mining industry has not always been able to absorb the number of students who graduate annually, but there is plenty of scope in India for graduates to prospect and to develop their own finds. A good living can be made out of a small mineral deposit by energy and with average luck. Large deposits are rare finds, but there are innumerable small occurrences waiting to be found and developed. So long as these are worked carefully and kept out of the hands of that type of company promoter who would merely use them as a means of raising large capital funds, the prospector should have some success........ Singhbhum and the surrounding areas should be the happy hunting ground for such prospectors........ Copper and iron mining can only be undertaken by large companies, but apatite, gold, asbestos, talc, clay, kyanite, refractory quartzite, and road and railway ballast can often be profitably worked by individual miners."

There is in fact an excellent field of research in the use of the apatite and vanadium deposits.

Rock as a Subbstitute for Soda ash in Glass Industry

There is in large quantities in India a certain kind of rock, which, if correctly used by glass manufacturers, would make, to a large extent, the present expensive imports of soda ash unnecessary. This observation is made in a scientific paper, published recently by the Industrial Research Bureau of the Government of India, and written by Dr V. S. Dubey, and Mr P. N. Agrawala. The authors point out that most of the glass made in India is soda lime glass, for which the raw materials required are sand, lime and soda ash. Of these three materials the first two are abundant in India, while soda ash has to be imported at a price about 60 per cent higher than it is in England and other countries which produce their own. On the average, soda ash represents a considerable proportion of the cost of raw materials for making glass in India. Details are given by the authors of experiments which show that it is possible to replace about 50 per cent of the soda ash used by Indian glass manufacturers with certain kinds of rocks to be found in India. As a result of this process it is claimed that it is possible to reduce the cost of raw materials by 30 per cent. More than one kind of rock could be used for this purpose, but the authors came to the conclusion that the nepheline syenite variety was best suited for the glass industry, being easily accessible and occurring in large deposits. For example, there is a huge outcrop of this particular rock at Krishangarh (Rajputana) about two miles from a railway station. This rock also occurs in Kathiawar, in the Coimbatore district (Madras), and near Vizagapatam. The only drawback to the use of this particular rock is that it contains a high percentage of ferro-magnesium minerals. It is pointed out, however, that this could be easily and cheaply extracted, so that this would be only a small difficulty.

Indian Central Cotton Committee

The annual report of the Indian Central Cotton Committee which has just been published reviews the work of the Committee for the year ending 31st August, 1936. The report says that the investigations

August, 1936. The report says that the investigations

undertaken by the Committee into the possibilities of growing cotton of long and medium staple in the present short staple cotton areas of India, have provided valuable information for framing future cotton policy of the country. Steady progress was maintained in the matter of encouraging superior types of cotton by eradicating inferior short staple varieties growing in the same tracts. A bill for the prohibition of the cultivation of the inferior Garrow Hill Cotton, duly endorsed by the Committee was introduced in the Central Provinces Legislative Council. The Bombay Legislative Council also passed a similar act to eliminate the inferior Goghari cotton from the Surat tract. The Government of Baroda have applied the provisions of the Bombay Act with slight modifications in their territory. In order to suppress the many malpractices existing in the cotton trade such as the watering and the fraudulent mixing of cotton, the Committee advocated the introduction of legislation for the licensing of gins and presses for checking the various malpractices. The Bombay and Central Provinces Governments have introduced the necessary legislation within their jurisdiction. Hyderabad state introduced legislation of this type, as long ago as 1931. It is to the credit of the Committee that as a result of exhaustive research work carried out under its auspices and financed by it, that the U. P. Government have passed legislation for controlling by a seed heating process a pest called the Pink Boll-worm which destroyed upwards of 25% of the crop in normal years and nearly 50% in some years, in United Provinces.

The Indian Central Cotton Committee finances a great many research schemes, botanical for breeding high yielding superior types of cotton; entomological for the study of the life history of certain cotton pests and finding out measures to combat them; mycological for ascertaining ways and means to prevent loss due to wilt and root rot; and physiological for the investigation of crop growth and bud and boll shedding. During the year under review there were 29 research schemes and 17 seed extension and marketing schemes under operation, with a view ultimately to putting more money into the pockets of the cultivator of cotton; whose welfare is the chief concern of the Committee. The total amount sanctioned for the schemes being Rs 5,75,000.

During the year under review the mills in India consumed 2,677,572 bales of cotton of 400 lbs. nett. The exports for this period were 3,826,000 bales of 400 lbs. nett against 3,115,000 bales in the preceding year. The Publicity Department of the Indian Central Cotton Committee did valuable work by all available means of publicity by carrying on an informing campaign in the dissemination of knowledge relating to the culture and industry of Indian cotton.

Open pan Sugar Industry

We have received from one of our readers an interesting letter on open pan process in sugar industry. Our correspondent has tried to show that though the efficiency of the process is low, it is very useful under certain circumstances and therefore deserves attention and encouragement from scientific workers. We give below the relevant portions from this letter.

"The development of modern sugar factories in India has led some people to think that the open pan industry has now no place in the country and should, therefore, be abandoned and that it is not worthwhile to improve it. The purpose of this note is to point out that the open pan process, although its efficiency is undoubtedly low, still has good reasons for its continuance in the country.

"One chief reason why the open pan system is still of considerable importance is that in certain parts of India where cane is not grown in large compact areas, there is little room for starting large scale sugar factories that can compete successfully with factories in other parts of the country. In the Central Provinces, for example, the local Government, while examining the possibility of developing the sugar industry in the province, found this to be the case and have therefore taken steps for demonstrating the use of centrifugal machines and the open pan process, which holds out better prospect of profit for the grower in that province. Information to this effect was supplied by C. P. Government in reply to a question in the Legislative Council.

"According to the Punjab report on the operations of the department of agriculture for the year ended June 30, 1934, the manufacture of white sugar as a cottage industry by the open pan process is gaining in popularity, though good pan-men are not abundant and by reason of this shortage, classes were organized at Jullundar to teach '*rab*'-making.

As regards Bombay, the results of the recent experiments (Bulletin No. 175 of 1934 on the *Manufacture of white sugar and Gul by the open pan process* by V. V. Gadgil, B.Ag.) carried out by the Bombay presidency agricultural department definitely indicate there is still a place for sugar making by the open pan process, *i.e.*, there is still a margin of profit for those who follow this method. Even in the U.P., where the number of modern sugar factories is by far the largest, there is a fairly good number of *Khandsari* concerns in operation, equipped with electrically driven centrifugal machines.

"Another point which also deserves mention in this connexion is that while the modern factories require capital and organization beyond the means of an average petty capitalist in India, the low capital expenditure involved in the open pan process of sugar manufacture puts sugar-making within the reach of even peasant cultivators. Some of the cultivators therefore make their own sugar while some prefer to sell their cane to *Khandsari* owners only on grounds of convenience since the *Khandsari* process is carried out in the village itself. Mention may also be made here of the fact that there is a definite demand, however small it may be, for *Khandsari* sugar at least in the rural areas on account of the Indian sentiment against the use of bone-charcoal in the modern processes.

"It will be seen from the above paragraphs that the open pan system of sugar production has certainly got a place as a cottage industry in India. Its future, however, depends upon the amount of co-operation and help that scientific workers extend to it. Further improvements which will increase the percentage yield of sugar and bring down the cost of production are needed to be devised in the present process. Some may suggest that it is not worthwhile trying to improve and popularize the open pan system which is less paying than the modern factory method. One must not, however, forget that the *Khandsari* system is the little man's industry in India and as such its low efficiency, far from being a reason for not attempting to improve it, seems to be a strong reason for a further programme of research in this direction."

Industrial Development of India

This month we are publishing two articles in this section, one by Professor Schroff of Benares Hindu University and the other by Mr K. L. Roy of the Department of Applied Chemistry, Calcutta University. Professor Schroff, in his article, pleads for a greater co-operation between the industrialists and the Indian universities and shows that for industrial development of the country, research and scientific planning are essential. Further comments here are unnecessary as the subject has been discussed at some length in the editorial article this month.

In view of the fact that many countries in Europe (e.g. England and Germany) have recently established big factories to produce liquid fuel from coal on a huge scale, Mr K. L. Roy's article will be of special interest. In this article he has gone into the historical and scientific aspects of the subject and has shown that the crude method of stock burning of coal prevalent in India is highly wasteful as about 10 gallons of liquid fuel are lost for every ton of coal burnt in this way, which means that we loose about 10,000,000 gallons of liquid fuel each year.

Industrial Co-operation and Indian Universities

M. L. Schroff
Professor of Pharmaceutics, Benares Hindu University.

The role of chemistry among other sciences, in the development of the resources of a nation was never before brought home so vividly to the minds of men as during the last European war; and every student of science knows how the German chemists saved their country from an early disastrous defeat. In the civilized world today, chemistry is interwoven with all the necessities of life. Our dress, food, shoes, medicines, entertainments and practically all such things as come under the term 'luxuries' are the products of chemical processes which are being carried out daily in workshops mostly outside India. It is for this reason that we should turn our serious attention to the problem of making India self-sufficient at least in regard to the necessities of life.

India is far behind other countries in industrial research. Real industrial research is practically unknown in this country. The capitalists and industrialists are ignorant of the role of science in industry and are indifferent, in consequence, to the development of the resources available in the country. While in other industrially advanced countries there are a large number of scholarships and fellowships granted in various universities for carrying on research on industrial problems, very few exist in India. In many American universities, for instance, there are special research fellowships granted by Laundrymen's Association, Palmolive Soap Company, National Kraut Packers' Association, Potash Export Company, Edgar Plastic Kaolin Company, the Corn Products Company, the New York Florists' Club, the Nagara Sprayer and Chemical Company, and a host of others for carrying on research on different problems. There are also scholarships of general industrial nature granted by the well-known Bakelite Corporation, E. I. duPont Company, etc., for encouraging research on other industrial projects. But in India even the most paying industry such as that of sugar has not cared to institute any scholarship or fellowship for research on sugar and the utilisation of its byeproducts. This shows what a big gulf exists between the Indian and the Western industrialists. If the Sugar Association had taken the initiative, by this time it would have gained much more than it could possibly have spent for promoting research in this line.

The foreign universities have played a very important part in bringing about the economic prosperity of their respective countries. The general public, the businessmen and the manufacturers have realized, in the various industrially advanced countries, that in supporting great scientific research laboratories of universities and technical schools they are really sustaining important centres of work, which will improve products, abolish waste, promote new industries, preserve life and thus help materially, in the long run, all those activities which make nations great. At the Massachusetts Institute of Technology, Cambridge, U.S.A., there is a Department of Industrial Co-operation and Research. The department is under a director who is also a professor of applied chemistry at the institute. There are also assistant directors and other staff. This department brings about effective co-operation between the industries and the Institute. It is through this department that arrangements are made for courses like the Chemical Engineering Practice course for imparting instruction for a few months in the factories where theoretical classes are held in the evening and the practical training is given during the day. Research work is also carried on in many departments at the suggestion of industrialists. Many research workers are turned out from the laboratories of this Institute every year and these eventually occupy positions of responsibility in industries. Many well-known scientists connected with industries, visit the Institute at times and deliver lecture on various topics. A large number of professors are consulting chemists and consulting-engineers and guide research on applied sciences, the cost of which is borne by the industries. A large number of graduates and researchers find employment while getting training at the Institute.

It is high time that the Indian universities also should develop a well-planned policy of industrial research and invite the co-operation of industrialists. To my mind all those universities which have departments of applied sciences should evolve a five-years' plan for research suited to Indian needs. At the same time they should organise some departments of the type existing at Massachusetts Institute of Technology in co-operation with industrialists. In American universities most of the fellowships for these special researches entitle the holder of the fellowship to a remuneration of about Rs 250/- per month; besides, some suitable grant is made to the university for meeting the expenses of the project. In India also a research fellowship to the value of about one thousand rupees annually and the requisite grant to the universities for a period of at least three years should be provided by businessmen and industrialists. Each university should plan out the researches and sponsor them with strict reference to the needs of the province or the country and duplication should be avoided as far as possible. There should also be an advisory committee, attached to each university consisting of the vice-chancellor, the heads of the departments of applied sciences and some business magnates. It should be the function of this committee to discuss all important problems of industrial nature and chalk out a definite programme of work after mature deliberation. This will remove all suspicion from the minds of businessmen and bring about a healthier atmosphere between universities and industries. The meetings may be held twice a year and a stocktaking may also be done at that time in order to discourage any slackness on the part of research workers, if any. If researches are pursued according to some chalked-out programme, much work of industrial importance can be turned out which will help in the regeneration of the country's prosperity and well-being.

Practically no basic industries exist in India. The following figures for the import of some of the important articles during the year 1935 are given below to show what industries need immediate tackling:—

ARTICLES	QUANTITY		VALUE (in rupees).
Bleaching powder	218,051	cwts.	12,86,930
Sodium Carbonate	1,287,324	,,	67,15,035
Caustic Soda	393,188	,,	41,44,043
Camphor	2,288,154	lbs.	22,85,824
Sulphur	500,877	cwts.	19,91,486
Sulphate of Ammonia	44,029	tons.	43,29,651
Aluminium	69,594	cwts.	48,90,886
Artificial silk	15,912,951	lbs.	94,79,518

Besides the above articles of which the import figures are high and which can be manufactured out of raw materials available in India, there are a large number of other articles, which, though imported in smaller quantities, are industrially important. Among this class may by mentioned acetic, oxalic, and tartaric acids, alum and aluminium sulphate, glycerine, magnesium compounds, manganese compounds including permanganates, chromium compounds including bichromates, sodium compounds and sodium silicate, morphine derivatives, fertilizers containing phosphates, lithophone, barytes, starch, dextrine, etc. The manufacturing costs of all these need working out.

Caustic soda is one of the most important raw materials for a great many industries. Many industrialists are thinking of starting caustic soda plants, but the trouble is that one usually depends entirely on foreign manufacturers for specifications of plants and supply of machinery and equipment. Secondly, there is felt some difficulty regarding the utilization of the bye-product chlorine. If one were to start the smallest economic unit for the manufacture of caustic soda, i.e., 10 tons of caustic soda per day, there would be produced side by side 13 tons of bleaching powder, 6 tons of hydrochloric acid and 2 tons of liquid chlorine. Of course, in place of bleaching powder, hydrochloric acid and chlorine, some other products may be manufactured out of chlorine and hydrogen gas, but there being a good demand for bleaching powder for textile factories, the whole of this bleaching powder may be used locally if the factory is started in Bombay or its vicinity. However if it is not desired to manufacture hydrochloric acid, there will be a problem of utilization of hydrogen and the chlorine gas. The former may be utilized for hydrogenating cotton seed oil so abundant in the Bombay presidency, and the chlorine may be used for chlorinating benzene, which has to be obtained from coal tar. The chlorobenzene will give us phenol, a very important product medicinally as well as industrially. Chlorine may also be used for water purification or for the manufacture of solvents like chloroform, etc. However, the economic and chemical engineering sides of the problem have to be carefully worked out.

Phenol is used in the manufacture of bakelite and unless phenol is cheaply available bakelite manufacture cannot be undertaken. Of course, other synthetic resins can be manufactured without phenol, but in that case urea has to be obtained either by calcium carbide-cyanamide process or by some other cheaper method. It may be mentioned here that synthetic plastics can be manufactured from casein also, if milk is easily and cheaply available.

One of the greatest troubles in starting any factory in India arises from lack of information regarding designing of plants for various industries. The result is that a large amount of money has to be sent abroad even for purchasing ordinary equipment which could be very easily and cheaply manufactured in India. This tendency for getting even the ordinary equipment imported is partly responsible for the failure of many factories here. If any thing goes wrong with the imported equipment, we have to import tools and other things and thus our work suffers and the repairs are expensive. We cannot do anything in this line unless we have real departments of chemical engineering started in Indian universities. At present no chemical engineering is taught, no designing is done, and under the name of chemical engineering, a little of drawing, mechanical and electrical engineering is taught and hence the whole training becomes practically useless where a knowledge of chemical engineering is required. If the departments of chemical engineering are organized properly, students could be trained in the design of small scale commercial plants and the plants could be actually designed and experimented upon in the laboratories for the manufacture of various products. I know of factories which have spent several lakhs in purchasing equipment but I also know of engineers who have by their own constructive skill brought into being the same equipment and that too at only a fraction of the cost.

Unless we develop departments of chemical engineering where we can train people for designing equipment for chemical industries to suit Indian needs and where members of the staff also do designing work themselves, it will be practically impossible to start many of the industries profitably. We shall have to import experienced chemical engineers from abroad to do the design for us here at a fabulous cost. In my enquiries from various concerns in many countries in Europe and America I learnt that most of the equipment with the exception of some special or patented apparatus has been designed and prepared by the promoting concerns themselves to suit individual needs. The manufacture of synthetic ammonia requires no raw materials besides coal, air and water but the whole question is of the design of apparatus requiring good knowledge of chemical engineering. Of course, some part of the apparatus must be imported but part of the apparatus can be manufactured here. Then is the question of sulphuric acid for converting ammonia into ammonium sulphate. India has no sulphur deposits and all the sulphuric acid is manufactured from imported sulphur. This is a problem requiring a lot of laboratory and large-scale research, since India abounds in gypsum which can be utilised for supplying us with sulphuric acid as well as for directly converting ammonia into ammonium sulphate. If we are able to convert calcium sulphate into sulphuric acid, it is likely that we may get pure calcium oxide which is essential for the manufacture of calcium carbide.

I have shown above that camphor to the value or about twenty three lakhs is imported every year. The United Provinces have got the turpentine industry. It may perhaps be made immensely more remunerative if synthetic camphor is manufactured out of turpentine. The same may be said about the extraction of aluminium from bauxite. There are deposits of good quality bauxite in Bihar, Central provinces, Bombay Presidency and elsewhere and the aluminium industry has become so important in national economy that there should be no delay in working out the details of this industry and organizing the production of aluminium.

Calcutta is a big centre of production of *chhana* from milk. Maunds of water containing milk sugar are thrown away every day. It requires only organisation and then Calcutta can easily become the centre for manufacturing lactose and the waste can thus be turned to real use. Here the scientific brain and business sense must co-operate. The same thing can be said of the soap industry. The bye-product of soap industry, glycerine, is not recovered in India at all and this accounts partly for the high price of Indian soaps. If a central organization could take up this problem and collect all the waste lye and recover glycerine, a large amount of money could be saved and a very valuable product, required for the defence of the country as well, could be obtained. Of course, glycerine can be manufactured by fermentation methods also and this should also be worked up to supplement the requirements of the defence of the country.

I may just mention here that we should take in our hands also the growing of lemons for the extraction of citric acid and at the same time work out biochemical methods for producing the same. The biochemical industries are hardly known in India at all, and many valuable products which could be easily manufactured here are imported every year.

The co-operation of industrialists and Indian universities is of vital importance to the economic prosperity of the country and that there are a large number of problems requiring solution must be apparent from what I have written above in a rather sketchy manner. To suit Indian conditions and to encourage efficiency and bring about India's regeneration, attempts should be made to interest industrialists in the universities so that research fellowships way be endowed at the universities and industrial research carried on systematically according to some preconceived plan. The departments of applied sciences should be reorganized to make the training more suited in the universities so that research fellowships may research should be based on a five-year plan. Duplication of work in the sister universities should be avoided and each university should specialize in somelines suited to the needs of the locality.

Low-Temperature Tar and Liquid Fuel

Kanai Lal Roy

Ghose Researc: Scholar in Applied Chemistry, Calcutta University.

The generation of power in stationary engines offers no difficulties in coal-producing countries. It is always possible to burn coal under boilers and raise steam for power purposes, or to gasify it and to use the gas as a heating or motive agent.

Limitations in weight and space, both as regards engines and quality of fuel required, influence the generation of energy for transport purposes, as on board ship, in motor vehicles or aircraft. So long as electrical energy in large bulk cannot be carried more efficiently than present-day accumulators permit, we shall be restricted to the use of liquid fuels of relatively high potential energy for motor propulsion. High calorific value, small space occupied, freedom from incombustible constituents and many other advantages render liquid fuel indispensible for motor purposes.

Aircraft, motor cars and small boats call for low-boiling, commercial vehicles and large ships for high-boiling liquid fuels. The choice of fuel is determined by questions of fire hazard, type and speed of engine, the available space and permissible weight in the vehicles, and other considerations. Sea-going vessels are not likely to be run on petrol, even at very low petrol prices, but on oils of higher-boiling range on account of the smaller fire and explosion risk. In aircraft, on the other hand, motor-fuel of very low boiling points and high calorific value must be used, as only these are suitable for light, high-speed engines. It is, therefore, not likely that either now or in future a standard liquid fuel will be used, but different types will be required for different purposes.

The principal sources of liquid fuels are petroleum and the gasoline frequently present in natural gas. The latter and the low-boiling fractions of petroleum oil, petrol or benzine, are the motor-spirit of commerce. To these must be added the " cracked " spirit made by thermal decomposition of higher-boiling petroleum fractions, produced particularly in America on a very large scale.

The rapid development of motor transport makes countries not producing petroleum in more than negligible quantities depend on the importation from abroad, but shortage of crude oil, even in the most favourably situated countries such as the United States of America, is becoming more and more acute. Estimates of the oil left in the oil-fields of the United States indicate that they will barely last 20 years at present rate of consumption. The world's oil production has experienced a tremendous development during the present century and has reached one-tenth that of coal mines, amounting to about 120 million tons of oil as compared with 1200 million tons of coal.

The great advantage inherent in the possession of liquid fuel for the economic and political superiority of any country has led to keen competition for the control of oil deposits of the world. It is to be expected that the victors in this struggle for oil are not likely to give up to other countries more than the surplus over their own requirements. These other countries are forced to seek means by which substitutes can be found for petroleum.

For this reason science and industry have begun seriously to study the possibilities of a discovery of new kinds of liquid fuels, and to work out suitable chemical methods to this end.

The first work on the production of liquid fuel was done by Berthelot (*Bull.*, 1869, [2], 11, 278; *Ann. Chim.*, 1870, [4], *20*, 526). He succeeded in converting natural coal into oil by hydrogenation. For this purpose he treated coal with about 100 parts of saturated hydroiodic acid at 270°C for about 24 hours and obtained liquid products amounting to 60% of the weight of coal. The liquid was then subjected to two series of fractional distillation and he isolated a small quantity of hexane, boiling at about 70° C.

After the hexane several hydrocarbons came over which showed the general properties of saturated hydrocarbons. The mixture was too complex to admit of accurate separation. Apart from coal, Berthelot also took wood and charcoal and succeeded in preparing liquid products rich in saturated hydrocarbons. The experiments of Berthelot were extended by a large number of workers, till at last, Bergius made it an industrial success by the hydrogenation of coal or other solid carbonaceous material of vegetable origin at high hydrogen pressure. (Bergius, Brit. Pat. No. 18,232 of 1st August 1914).

Other attempts for the production of liquid fuel are the catalytic experiments with carbon monoxide and hydrogen under pressure. In *Friedländers Fortschritte der Teerfarbenfabrikation* (*12*, 899, 901), patents of the Badische Anilin-und Soda-Fabrik are recorded showing that the production of liquid hydrocarbons and their derivatives can be effected by submitting carbon monoxide and hydrogen to a contact process under pressure. The patents emphasize the fact that mainly liquid hydrocarbons are formed, the contact substances being pure asbestos impregnated with pure-cobalt oxide or osmium-oxide together with a little caustic soda. Generally a pressure from 100 to 120 atmospheres and temperatures varying from 300°C to 420°C are required in the experiment.

The decomposition of metallic carbides by water and subsequent condensation and polymerization of gaseous products into various solid and liquid hydrocarbons is another attempt at getting liquid fuel from coal. The brilliant works of Novák (*Z. Phys. Chem. 73*, 513, 1910), Richard Mayer (*Ber. 45*, 1609, 1912), Sabatier (*Catalysis in organic Chemistry* page 393), H. P. Kaufmann (*Ann. 417*, 34, 1918), and N. Zelinsky (*Comt. rend., 177*, 882, 1923; *Ber., 57*, 264, 1924), in this line explain the possibilities of the formation of liquid fuel from carbides, although no largescale experiments have as yet been made by them. In his work N. Zelinsky has shown that the polymerization of acetylene to benzene takes place with a much better yield, if the acetylene absorbed by activated carbon, is exposed to a temperature of about 600°C. He succeeded in obtaining 70-74 per cent by weight of the acetylene as a light tar, half of which boiled below 150°C and contained about 85% of pure benzene. The high-boiling fractions contain toluene, xylene, styrene, indene, napthalene, fluorene and anthracene. One hundred parts of acetylene tar yielded the fractions: 20°-150°C, 45%; 150°-250°C, 14%; above 250°C, 29%; residue, 12 per cent. The amount of liquid motor fuel would be 59% of the weight of tar or about 40% of the weight of acetylene.

One of the new possibilities for the production of liquid fuel on a large scale is low-temperature carbonization particularly of bituminous coal. When coal is subjected to destructive distillation at temperatures 400° to 500°C; it yields a tar, which mainly consists of aliphatic hydrocarbons and thus differs from ordinary gaswork or coke-oven tar, as was first shown by Börnstein (*J. Gasbeleucht., 49*, 627, 648, 667, 1906). The subsequent works of Fischer, Gluud, Broche, Frank, Arnold and Engler show that the hydrocarbons of primary tar are more closely related to petroleum than to coke-oven tar, and particularly to oils which are napthenic in character. The mixture of hydrocarbons in primary tar is optically active, as Fischer has established in collaboration with Gluud (*Ber., 50*, 11, 1917). Optical activity has so far been found only in petroleum but not in coal tar.

In order to produce oil by carbonization of coal, it is necessary to reach the decomposition temperature (400°-500°C) of all the constituents capable of forming oils. It is advantageous not to raise the temperature beyond that absolutely required, so as to avoid any secondary superheating of the oil vapours, and even to cool the vapours as rapidly as possible to temperatures below 300°C. Prolonged heating to higher temperatures would lead to the decomposition of volatile constituents with formation of gas and a consequent diminution of the tar yield. The crude product of distillation containing the oil is called primary tar (*'Urteer'*).

The technique of low-temperature carbonization has made considerable progress in recent years particularly in Great Britain. For the process of low-temperature carbonization, as it is understood to-day, there is little doubt that credit must be given to Mr T. Parker, of "Coalite" fame. Parker's first patent was granted in 1890, but his principal patents for the process were taken out in 1906. Following Mr Parker, Richards and Pringle, Tozer, Maryhill, Del Monte

Research Notes

Surface Wave in Radio Propagation

The problem of the determination of field strength due to a vertical earthed antenna is of extreme practical importance to the radio engineers. It offers an easy solution if the earth is considered as flat and perfectly conducting. In fact, Hertz's classical solution of the field strength due to an electric doublet oscillating in free space is easily applicable without any modification. In actual practice, however, the earth is far from being perfectly conducting and further, its dielectric constant differs from that of the atmosphere above the surface. In such cases the problem of finding out the field strength of the doublet becomes extremely complicated. The analysis, though difficult, has however been made by Sommerfeld in which he has found that the interface of the two media—the earth and the atmosphere, *i. e.*, the surface of the ground is the seat of the so-called surface waves. Previous to this the existence of the surface waves was also suggested by Zenneck.

Similar problems, namely the propagation of wave from an oscillating doublet situated near the interface of two media, have been studied by Weyl and by van der Pol and Niessen. In spite of certain discrepancies these calculations, till recently, were considered to agree with Sommerfeld's solution. In 1930 Rolf extended Sommerfeld's curves for the variation of the field with distance ; these curves, except for minor criticisms, were also accepted as correct.

Some time ago, however, in a paper in the *Proceedings of the Institute of Radio Engineers* (24, p. 1367, 1936) Norton questioned the correctness of Sommerfeld's solution. He derived an empirical formula which differs from Sommerfeld's equation but which is in closer agreement with Weyl's and with van der Pol and Niessen's formulas. In fact, the disagreement is of the some nature as the discrepancies mentioned above and it is shown that the latter formulas differ from Sommerfeld's by the term expressing the strength of the surface wave.

To solve this mathematical ambiguity Burrows (*Proc. I. R. E.*, *25*, 219, 1937) has recently attempted to decide the matter by experimental investigation. The two formulas, Sommerfeld's and Norton's, predict field strengths that differ enormously for shortwave propagation over fresh water. Accordingly Burrows measured the field strength of a shortwave transmitter over deep water (lake Seneca, N.Y.) and found that his results agreed, closely to the formula of Norton.

This agreement of the analysis of Norton with the experimental results of Burrows has thus raised considerable doubts regarding the existence of Zenneck-Sommerfeld surface waves.

K. K. Roy.

The Source of Vitamin D in Summer Milk

It is well known and generally accepted that vitamin D content of cow's milk is subject to seasonal variation, and that it is higher in summer than in winter. Some workers were of opinion that the increase observed in summer is due to the properties of the summer pasture compared with those of foods used in winter, while other workers opined that the direct action of the sun on the cow during summer is responsible for this increase. Consequently, no agreement has so far been reached as to the exact cause of this difference. Campion, Henry, Kon and Mackintosh (*Biochem. J.*, *31*, 81, 1937) now took up the investigation on the subject to decide whether it is food or the sun or a combination of both the factors that is responsible for this difference. They used eight Shorthorn cows for their experiment which was carried out during May and June when the actinic activity of the sun is high and grass is plentiful there. The cows were divided into four groups, each group containing two cows. In group 1, the cows were kept under housing and feeding conditions. In group 2, they were kept under winter feeding condition but exposed to the summer sun. In group 3, the cows were kept under normal summer conditions. In group 4, they were kept under summer feeding condition but not exposed to the sun. Butter churned from the pooled milk of each group of cows was then tested by rat feeding experiments. From the results of their experiments they conclude that it is the sun alone that is responsible for the increase in the vitamin D potency of the milk which takes place in the summer. The pasture has nothing to do with it.

H. N. B.

Sinanthropus Pekinensis

In *Nature* (February 13, 1937) Dr Weidenreich has announced the discovery of three additional, more or less well-preserved skulls of the *Sinanthropus pekinensis* type from Choukoutien. All the three skulls belong to adult individuals. The skull recovered first is the largest of all *Sinanthropus* skulls found hitherto. It shows a cranial capacity of approximately 1200 c. c. and the coronal and the sagittal sutures have partly fused. The skull is missing in many parts; the right temporal only is present. The second skull, the smallest of the group, possesses a cranial capacity not higher than 1050 c. c. and its coronal, sagittal, and lambdoid sutures have all fused, though the metopic suture is clearly present. Both the temporals are present but a great portion of the supraorbital is broken. Considering the other characteristics it appears that the skull belongs to an adult female. The third skull is smaller than the first but larger than the second. This skull is the most complete one; the entire occipital bone with the posterior border of the foramen magnum is preserved. The right temporal is missing. The cranial capacity is approximately 1100 c. c. and the skull belongs to an adult young individual. All *Sinanthropus* skulls possess a large and a small type of teeth. Dr Weidenreich is of opinion that the larger teeth belong to male individuals and the smaller to the females. This has also been confirmed by their respective presence in the first and the second skulls described above. From the essential measurements of the skull compared with that of *Pithecanthropus*, Neandarthal, and recent man it is seen that the *Sinanthropus* occupies the lowest place in order of all hominids in regard to the peculiarities determining its position in the line of evolution. This is true of the second skull (female) while the first falls within the range of variations of the Neandarthal group. The female skull is evidently lower than the *Pithecanthropus*; it shows a more pronounced frontal tuber while in *Pithecanthropus* the entire forehead is flattened. This smallness and lowness is remarkably present in the skull fragments recovered last summer which belongs to an adult individual. The dimensions of these skull fragments are still smaller than the respective parts of the female skull of the present series and the *Pithecanthropus*. In view of the absence of any appreciable difference between *Pithecanthropus* and *Sinanthropus*, so far as the general shape and lowness of the skull are concerned it is probable that the *Pithecanthropus* belongs to a female sex, a probability also pointed by Dubois and Hrdlicka.

Dr Weidenreich has also been able to show some close connexion between *Sinanthropus* and certain groups of the Mongol race. The presence of 'torus mandibularis' on the inner side of the mandible of some *Sinanthropus* jaws and the Eskimos and the Lapps and the shovel-shaped medial and lateral upper incisors in *Sinanthropus* and in some modern Mongols indicate some direct relationship with the Peking man. The author is not yet bold enough to correlate the broad and flat nose of *Sinanthropus*. A special relationship can, of course, be assumed in the presence of the "inca-bone" which is found among the Mongols up to 7.8%. All the three skulls of the present series show a large inca-bone.

That the *Pithecanthropus* is considered as an advanced type than the *Sinanthropus* is also supported by the supraorbital ridges and its connexion with the formation of the frontal air sinuses. The broad furrow in the supraorbital ridges of the *Sinanthropus* shows air sinuses very small and closely confined to the inter-orbital region while in *Pithecanthropus* they are conspicuously large and extend far lateralward over the roof of the orbit. Dr Weidenreich also sees many common characteristics with *Javanthropus* which has got undoubted affinities with *Pithecanthropus* and the author believes the latter to be a special female type of *Javanthropus*. *Javanthropus* represents a very primitive type of Neandarthal man and according to Dr Weidenreich the line linking *Pithecanthropus* and *Sinanthropus* respectively through *Javanthropus* or Neandarthal to recent man is continuous. Dr Dubois, however, in his recent study (*Nature*, Feb. 13, 1937) removes *Pithecanthropus* from the human line associating him with the gibbon.

S. S. Sarkar.

Total Solar Eclipse of June 19, 1936, and the Ionosphere Observations

So far all the investigations of the ionosphere during various solar eclipses have, in general, shown that the maximum electron density of the various layers decreases as the visible area of the sun's disc decreases, reaching a mimimum at totality ; and after the eclipse maximum, as the visible area increases, the density begins to increase. The results are not in general in favour of corpuscular eclipse, though some investigators think that their experimental results are in favour of a corpuscular eclipse. The general conclusion is that the ionization is due to energy propagated at a speed equal to the velocity of light or in other words to ultraviolet light.

Recent observations of the ionosphere during the solar eclipse of June 19, 1936, have yielded very interesting results. G. Leithäuser and B. Beckmann (*Zeitschr. f. tech. Phys.*, *17*, 327, 1936) report to have observed a decrease in the ionization with the decrease in the visible area of the sun, which was not followed by an increase as the visible area increased again after eclipse maximum. There was a further rapid decrease which lasted the whole day. The authors come to the conclusion that the ionosphere does not take part in the earth's rotation so that the observing station approached the totality zone, with the progress of the day. Another possibility is that the ionization of the upper regions is due to corpuscular radiation from the sun.

The above hypothesis of the non-rotation of the ionosphere has been supported by G. Leithäuser and W. Menzel (*Zeitschr. f. tech. Phys.*, *17*, 330, 1936) from their study of the propagation of atmospheric disturbances and the reception of distant stations during the same solar eclipse.

I. Ranzi (*Sa Ricerca Scient. 2* 327, 1936), however, reports to have observed two minima in the electron density in the F_2-region, one about thirty minutes before, and the other about 20 minutes after the eclipse maximum.

R. R. Bajpai.

The Mother-Goddess of Gandhara

In *Antiquity*, March, 1937, 70-79, Major D. H. Gordon publishes an interesting article on the above subject. He points out that in the Gandhara region the rites of the Buddhist creed and the worship of the mother-goddess and her consort were prevalent at one and the some time. He identifies the peg-shaped terra-cotta figures with pinched-out nose and applied incised eyes, naked but for ornaments, a girdle, necklace, bracelets, anklets and the channavira[1] as representations of the mother-goddess. The figurines generally fall under three types : the archaic, the Hellenistic and the Indian. Coomaraswamy proposed to refer the archaic ones to the second millennium B. C., but this is shown to be against archaeological evidence, the Sari Dheri west mound, the prime source of the archaic figurines, revealing the coins of Azes quite low down. The writer draws attention to a class of objects found at Sirkap, consisting of a walled enclosure, with lamps at corners, birds on three walls and a shrine in the centre of the fourth, and with steps leading to the shrine, outside which stands a figure of the mother-goddess; inside the enclosure are small pillar-like objects and a fragment of a similar enclosure shows two snakes and a pillar. The discoverers regarded these objects as offering tanks. But it is here suggested that they are in reality votive shrines, the birds being doves, and they, together with the snakes, pillars and lamps, constituting the whole of the adjuncts of the worship of the mother-goddess. The mother-goddess in terra-cotta is linked with the figures of Hariti, with whom the philosophy of Buddhism had to share its sanctuaries and worship. Kubera, the male companion of Hariti, is regarded as the true linear descendant of all those chthonic gods of wealth and of the underworld who are to be associated with fertility cornucopia goddesses.[2]

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[1] 'A jewelled chain cro sed diagonally across the front of the body from shoulder to opposite hip'.

Regarding the introduction of this particular cult of the mother-goddess, Major Gordon suggests that it came to north-west India at the time of Antiochos the Great of Syria in *circa* B. C. 200. It is unlikely that the cult was entirely foreign to the inhabitants, but it took a Syro-Persian complexion, which is observable in the votive terra-cottas and later on in the Hellenized mother-goddess with her cornucopia and mural crown. The cult was wisely accepted and given a prominent place in Buddhism, as is shown by the position of the votive shrines and the importance of Hariti.

Major Gordon rightly complains that in India there has been a great deal of literary antiquarianism. A discovery to provoke interest must be capable of being traced to a reference in the Puranas, the Mahabharata or the Jatakas, or failing that to some recognizable element in Hindu, Buddhist or Jaina iconography. Where such a link is missing it is created with a naive disregard of scientific method, or else the objects found are passed over as being unworthy of attention.

A. Ghosh.

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[2] It is suggested that the words *Cabiri*, *Kabeiros*, *Kubera*, indicate most probably the origin of this god and his link with the fertility mystery.

Hindu Mathematics

History of Hindu Mathematics—a source book. Part I. Numerical Notation and Arithmetic, *by Bibhutibhusan Datta, D.Sc., & Avadhesh Narayan Singh, D.Sc. Published by Motilal Banarsi Das, Lahore. Price Rs 6/-*

The volume before us is a welcome addition to the history of science in general and to the history of Indian science in particular and the authors, both of whom are accomplished mathematicians, are to be congratulated on having accomplished their tasks with so conspicuous success. It is well known that the world is indebted to ancient Hindu *savants* for the invention of the decimal notation. Regarding the great services of this invention the celebrated astronomer, Laplace, remarked nearly a century and a half ago:

> "It is India that gave us the ingenious method of expressing all numbers by means of ten symbols, each symbol receiving a value of position, as well as an absolute value; a profound and important idea which appears so simple to us now that we ignore its true merit, but its very simplicity, the great ease which it has lent to all computations, puts our arithemetic in the first rank of useful inventions; and we shall appreciate the grandeur of this achievement when we remember that it escaped the genius of Archimedes and Apollonius, two of the greatest men produced by antiquity".

Some fifteen years ago, an attempt was made by Mr G. R. Kaye, who was for some time inspector of schools in the Delhi division, to prove that the invention of the decimal notation was not due to the Hindu *savants*. Attempts have also been made in other quarters to prove that the decimal system was known in other ancient countries. In view of the doubts which were thus raised, our authors took upon themselves the task of examining the claims of the Hindus critically. They have critically examined the extant literature of the Hindus, Buddhists, and Jains for references to their conceptions on arithmetic. They have started with the Vedas and have taken us through all the subsequent literatures up to about the sixth century A.D. They have examined the epigraphical evidences as far as they have come to light. They have established to the satisfaction of every reasonable mind how the science of numbers was gradually developed and took its final shape about the sixth century A.D., how the ancient Hindu *savants* from the second century B.C. experimented with different ideas for the proper representations of numbers, how ultimately they came to the realization of the place values and the method of representation of numbers based on these principles, with the aid of nine numerals and the zero. They have shown that the invention was not sudden, but had to pass through a number of stages before it took its present and final form. They have further completely refuted the arguments of Kaye regarding the non-Indian origin of the decimal notation. Further, they have also examined references in the writings of many eminent Arabic and Syrian authors from 750 A.D. to 1200 A.D. in support of the Indian origin of the decimal notation. The conclusions of the authors can be thus summarized: "The earliest use of zero is to be found in the *Chhanda-Sutra* of Pingal (200 B.C.) in connexion with the solution of finding the total numbers of ways of arranging two things in n places, repetitions being allowed." According to our authors the earliest epigraphical record of the decimal notation is found in a plate-grant dated 595 A.D. The date (which is the Chedi era) 346 is given in the decimal notation.

But the authors have shown that the earliest use of the place-value principle with the word "numerals" belongs to the second or the third century A.D., in the *Agni-Puran*, the Bakhshali manuscript, and in the *Pulisha-Sidhanta*. The authors conclude, on the analogy of Europe and Arabia that, it must have taken 500 to 700 years before the decimal system was adopted by all sections of people in India and supplanted the other systems. In Chapter II, the authors have given exhaustive treatment of the methods of evolution of the different arithmetical principles like addition, subtraction, multiplications, divisions, squares, cubes, extractions of square root and cube root and the rules on fractions. If the reader has the patience to go through these sections he will find how the methods were being improved in gradual steps from very crude forms to the present day final forms in which these operations are taught to the students. The authors have further shown that some of the intermediate processes were transmitted through the medium of the Arabs to Europe to be subsequently discarded when better methods were invented in India and again transmitted to Europe.

This book is a monument of learning, profound study and of critical sifting of evidence. The large bibliography which is given at the end of the book bears testimony to the authors' extreme care and scientific outlook in approaching the problem. It ought to find its place in every scientific library and in every educated Indian home.

University and Academy News

Royal Asiatic Society of Bengal

An ordinary monthly meeting of the Royal Asiatic Society of Bengal was held on the 5th April, 1937.

The following candidates were balloted for as ordinary Members:

(1) Sharafuddin, S., M.A., B.L., Bengal Educational Service, Professor of Arabic and Persian, Islamia College, Calcutta. (2) Gupta, Miss Karuna Kana, M.A., Professor of History, Bethune College, Calcutta. (3) Sufi, M.E., B.A., D.P.H., L.R.C.P.E., L.R.S.E., L.F.P.S.G., Assistant Director of Public Health, Bengal (retired). (4) Sahni, Mulk Raj, M.A. (Cantab.), D.Sc. (Lond.), D.I.C., Geologist and Palæontologist, Geological Survey of India, Calcutta. (5) Wolfenden, Stuart N., Beverly Hills, California, U.S.A. (6) Roy, David, Assam Civil Service, Shillong, Assam. (7) Shirazi, Mohammed Ali, M.A., Lecturer, Calcutta University. (8) Mooney, Herbert Francis, M.A. (Oxon), I.F.S., Forest Adviser, Eastern States, Sambalpur. (9) Asari, J. R., B.A. (Hons.) (Madras), Retired Assistant Controller of Printing, Stationery and Stamps, Government of India. (10) Sattar, The Hon'ble Mr Abdur Razzak Hajie Abdus, Member, Council of State, Calcutta. (11) Sen, Kshitimohan, M.A., Shastri, Principal, Vidyabhavana, Visva-Bharati, Santiniketan, Dt. Birbhum, Bengal.

The following papers were read:

1. Eileen J. W. Macfarlane—*The Jewish Communities of Cochin, India; their racial Affinities.*

The Jews of Cochin totalled 1,451 in 1931, divided into two endogamous communities, the White and the Black Jews.

The White Jews a minority of under 150, claiming origin from Palestine in the first century A.D. to Cranganore, Cochin, where they were given autonomy over their estates, as well as other special privileges by an ancient Raja. Antique copperplate deeds which record these grants are still in their possession. They aver that the Black Jews are the descendants of Indian convert slaves of their ancestors, and are not of the Jewish race. The Black Jews declare that they are descended from Jews who came from Palestine before the Christian era, and explain their brown skins by a long sojourn in the Tropics. They claim that their ancestors owned the Cranganore estates and privileges, that the White Jews are new arrivals within the past 400 years who took the copperplate deeds from them. There are also two small sub-communities, one connected with each of the main groups. These are: (1) the descendants of White Jews and converted Indian concubines; (2) descendants of freed slaves and of Indian convert concubines of Black Jews. They are called Manumitted Jews. This proves that it has been customary here to free the Jewish children of servants and slave women. About fifty years ago the Black Jews appealed to the Chief Rabbi who declared that all of them were entitled to the full religious and social status of true Jews, providing that they observed the Law and their women and children took the Rabbinical bath called *Tabila*. Serological data were obtained in order to throw light on his controversy. They show that the distribution of the blood groups in the two communities is entirely dissimilar. The White Jews show 6p% Group A. This is due to inbreeding for the two largest families, who have intermarried frequently, are now apparently homozygous for gene A. The Black Jews show a disproportionate high percentage of Group O—73.6%. This group was found to be very high among the low castes and out-castes of Cochin. Native slaves and concubines would come from these poor classes, and the chances are 7 to 3 that a low class woman will carry the recessive gene R of Group O. Additions to the community have evidently taken place from Group O persons. Physically the Black Jews resemble the local Moplah Mohammedans who are descended from Arab traders and local women.

Physical measurements and genealogical diagrams are given for some families of the White Jews. They reveal a high degree of heterozygosity including two distinct head types, one brachycephalic and the other mesocephalic. Several of these people are blond.

There is inherited insanity and diabetes among them, but many are healthy and well-endowed mentally. Photographs are given to show some types among the White and Black Jews. The traditions of both communities have been correlated and peculiar customs of the White Jews recorded for the first time. New sources of historical data (French and Portuguese) have been revealed. A photograph of the Jewish copperplates has not heretofore been published to the writer's knowledge.

2. J. C. De—*The Development of the Theory of the divine Nature of Kings in Assam.*

An analysis of the terms used in inscriptions regarding Assamese Kings shows a definite tendency towards their deification.

The history of Assam may be roughly classified into three periods: early historical, Ahom and British. An analysis of the inscriptions shows that during the Ahom period there is a tendency to surround the king with mystic symbols, to make him participate in religious observances, to employ semi-divine priests as his advisers, to use the same words for deva and monarch, to ascribe to the earthly king descent from the king of heaven.

3. K. Krishnan Nair—*An abnormal Specimen of* Silurus Cochinchinensis *cuv. and val. showing Eversion of Stomach into the Pharyngeal Cavity.*

Description of large tumour-like growth in the mouth of a specimen of *Silurus Cochinchinensis* Cuvier and Valenciennes, belonging to a collection of fish made by V. P. Sondhi in the Southern Shan States, Burma. Reference to a similar abnormality in a Brown Trout (*Salmo fario Linn.*) recently studied by D. D. Mukerji.

4. D. D. Mukerji—*An abnormal brown Trout (Salmo fario Linn.) showing Eversion of Stomach into the Pharyngeal Cavity.*

Specimen of adult male of *Salmo fario Linn.* collected from amongst the fry in the local brown trout hatcheries, Kagan Forest Division, Hazara District, N.-W.F.P., where an epidemic of high mortality occurred.

A massive thumb-shaped structure was found on opening the pharynx. The structure proved to be formed as a result of the complete eversion and prolapsus of the proximal loop or the broad cardiac portion of the siphonal stomach into the pharyngeal cavity. The structures immediately following were pulled forwards and inwards and drawn into the everted sac in front of the gullet which also is everted and forms the posterior end of the sac. Detailed account of the abnormalities. Note concerning the probable mode of the ingestion of food. Illustrations.

5. M. H. Kyaw and G. E. Gates—*The Earthworm Populations and the Formation of Castings in Rangoon, Burma.*

The investigation was made in Rangoon during the rainy season, 1935, on two sample plots, ten feet square. Description of method. Statistical results. From the first plot 238 worms were collected belonging to at least six species, from second plot 168 worms also belonging to at least six, but not all the same, totalling eight species. The number of juvenile aclitellate and clitellate individuals was counted for each species. The average of earthworm population per acre as the basis of the two results works out at an average of 88,426.

Two types of castings were collected and weighed and analyzed. Influence of rainfall on formation of castings. Calculation of estimated amount of dry earth deposited as castings per acre results in 11,606 and 13,824 tons per acre for a period of a hundred days.

6. Kalipada Biswas—*Common Diatoms of the Loktak Lake, Manipur, Assam.*

Specimens collected by Dr S. L. Hora and the late Dr N. Annandale in 1920, from the Loktak Lake, Manipur. General introduction. Description of ten species. Illustrations.

7. K. Sen—*Some notes on rural Customs of Dinajpur District.*

More or less disjointed notes on some customs observed in the interior of the Dinajpur District. Area. Population. Hinduizing tendency amongst the Raybangshis, consequent change in the position of women, as well as in their costumes. Industries. Religious pantheon. Kali-worship. Protection against snake-bite. Cure of stomach-ache. Muhammadan Jumma-ghars. Tombs of saints. Rent-free lands attached to Hindu temples and Muhammadan shrines. Mandal-ship, selection of village headmen. Magical customs and rites. Conclusion: as the population is still primitive there may be some features which are not commonly found elsewhere.

Letters to the Editor

Acridyl Amino-Antipyrine

Since the observation[1] on the enhancement of the antimala ial activity of methylene-blue by replacement of one of its dimethylamino group by a dialkylaminoalkylamino chain, a great deal of work has been done on finding out the effect of insertion of similar chains to other nuclei, particularly quinoline and acridine. These investigations have resulted in the discovery of two well-known antimalarial drugs, namely 8-(ω-diethylaminoisoamyl) amino— 6 — methoxyquinoline[2] and 2-chloro—5—(ω—diethylaminoisoamyl) amino — 7 — methoxy-acridine[3], better known as "plasmoquin" and "atebrin" respectively. They also tend to establish the fact that the most effective parasiticidal portion of an anti-malarial drug is usually a quinoline nucleus. But in order that the heterocyclic ring might exert its specific toxic effect on the malarial parasites, it must be linked to certain other chain like dialkylamino-alkyl-amine as in the above two compounds, or the quinuclidine group as present in quinine itself. That a mere linking with a dialkylamino-alkyl-amine does not help the quinoline nucleus in this direction, is again evident from the researches of Slotta and Behnisch[4]. It would now be a natural development to study the influence of other substituents on the above ring system.

For this purpose, an aminopyrazolone derivative has been prepared from antipyrine by treating it with nitrous acid[5] and subsequently reducing the resulting nitroso-derivative to 4—amino-antipyrine[6]. On heating this compound with 5-chloro-acridines at 100° for a few hours, various 4—acridylamino-antipyrines are easily obtained. Thus, the 2 : 5—dichloro-7-methoxyacridine afforded 1—phenyl—2: 3 — dimethyl — 4 — (2′ — chloro — 7′— methoxy— acridyl) amino-5-pyrazolone, crystallizing from alcohol in fine microscopic orange yellow needles, m.p. 248°. It is readily soluble in dilute acids and is precipitated unchanged on neutralization. The nitrogen and chlorine estimations agreed with the formula $C_{25}H_{21}O_2.ClN_4$.

The pharmacological characteristics of the compounds are being ascertained.

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U. Basu.

1. Schulemann, Schönhöfer and Wingler, *Arch. Schiffs. Trop. Hyg.*, *30*, 11, 1926.
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3. Mauss and Mietzsch, *Klin, Woch.*, *12*, 1276, 1933.
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5. *Annalen*, *238*, 212, 1887.
6. *Cf. D. R. P.*, 71261.

Partial Purification of the toxic Constituents of Cobra (*Naja Naja*) Venom

The neurotoxin and the haemolysin are the two principal toxic constituents of cobra (*Naja Naja*) venom. These are always found associated with the proteins which constitute the largest fraction of dry cobra venom. Many attempts have previously been made to separate these toxins from one another and from associated nitrogenous substances. We have been able to obtain a highly purified sample of neurotoxin by adopting the following procedure.

10 c.c. of a 1% solution of cobra venom were dialysed against water in a cellophane bag until the non-protein nitrogenous substances were mostly removed. The dialysis was carried out inside a refrigerator maintained at 4°C. The solution, after dialysis, was mixed with an equal volume of a 44% solution of anhydrous sodium sulphate to precipitate part of the proteins present. This was carried out at

pH 5.2. The supernatant solution containing the major portion of the neurotoxin was separated from the precipitate by centrifuging. The precipitate was dissolved in water and again precipitated by the addition of sodium sulphate, the final concentration of the salt in the mixture being 22% as before. The supernatant solution was separated from the precipitate as before and mixed with the first fraction of the supernatant solution. To this solution enough anhydrous sodium sulphate was added to bring the concentration of the salt up to 33%. At this stage a further fraction of proteins along with some neurotoxin separated out. The precipitate was separated from the solution, dissolved and reprecipitated with sodium sulphate, the final concentration of the salt in the mixture being 33%. The two fractions of the supernatant solution rich in neurotoxin were mixed and treated with a 10% solution of sodium tungstate and 2/3N sulphuric acid, such that each 10 c.c. of the solution contained two drops of the tungstate and two drops of the sulphuric acid solutions. The precipitate obtained contained all the neurotoxin present in the solution. It was dissolved in 10 c.c. of water containing two drops of N/10 NaOH and the reaction of the solution was finally adjusted to *pH* 7·0. The nitrogen content of the solution was estimated by the micro-Kjeldahl method and the neurotoxin content was determined by intramuscular injection into pigeons weighing between 300 and 310 gms. The solution contained only neurotoxin and no haemolysin. It has been found that this purified sample contained 0.392 mg of nitrogen per 100 M.L.D. of neurotoxin, while the original dry venom contained 6.03 mg of nitrogen per 100 M.L.D. of neurotoxin. Assuming that the nitrogen in both the cases comes wholly from proteins it follows that 93.5% of the protein impurities has been removed and the neurotoxin has been concentrated within 6.5% of the protein substances present in the original dry venom.

The haemolysin of the cobra venom has also been freed from a considerable portion of the associated nitrogenous substances by the following procedure. It has been found that by treating 1% solution of cobra venom with sodium cloride so as to bring its concentration to 20%, more than 95% of the haemolysin in the solution comes down with the protein precipitate. The precipitate was separated by centrifuging, washed with 20% sodium cloride solution and redissolved in water. Its *pH* was then adjusted to 7.8 and it was placed in a water-bath at 86°C. After two minutes the solution became turbid, when one drop of N/5 NaOH solution was added; this was followed by the addition of another drop of the same caustic soda solution after about two minutes. By this method the major portion of the proteins was coagulated and it was removed by centrifuging. The supernatant solution was found to contain 1.86 mg. of nitrogen per 100 units of haemolysin, while the original venom contained 6.03mg. of nitrogen for the same number of units of haemolysin. Therefore about 71% of the nitrogenous impurities associated with the haemolysin as present in the original venom was removed. Further work is in progress.

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The Solidification of Cocoanut Oil

While investigating the insulating properties of some vegetable oils, a few interesting facts have been noticed during the solidification of the cocoanut oil. The solidification was found to start as agglomerations of needle shaped fat crystals all of which point towards a definite nucleus. Several star-shaped white crystalline bodies first appear on the surface of contact of the oil and the container and they then gradually develop as hemispheres with plane face on the walls of the container.

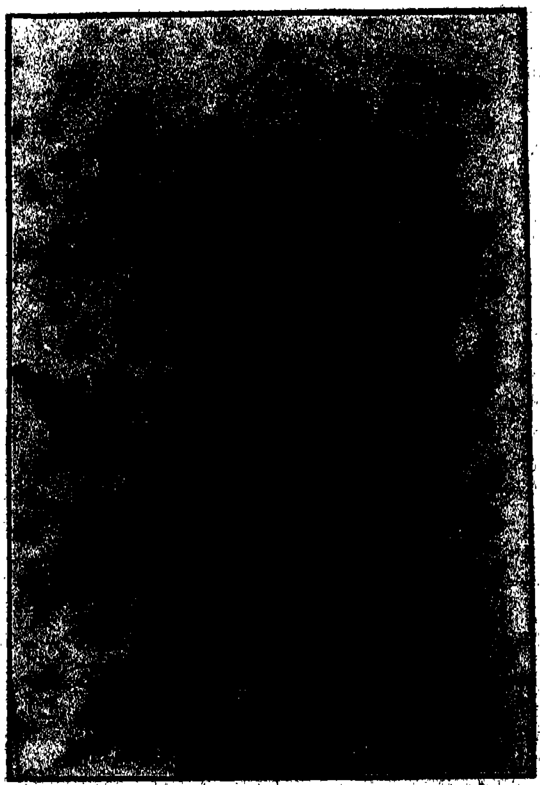

FIG. 1

Formation of white crystalline bodies in oil.

Photographs at different stages of development have been taken during solidification and the microscopic study of a very thin solidified oil film shows beautiful star-shaped bodies scattered all over the slide. High magnification (800-1000×) reveals that the nucleus is always associated with some substance other than fat, and is probably some aleurone grain or crystalloid inherent in the oil itself. It is not yet known whether these substances simply act as nuclei during crystallisation or they play some other part in solidification and attract the fat crystals towards them. Further investigations are in progress and the work in detail will shortly be reported elsewhere.

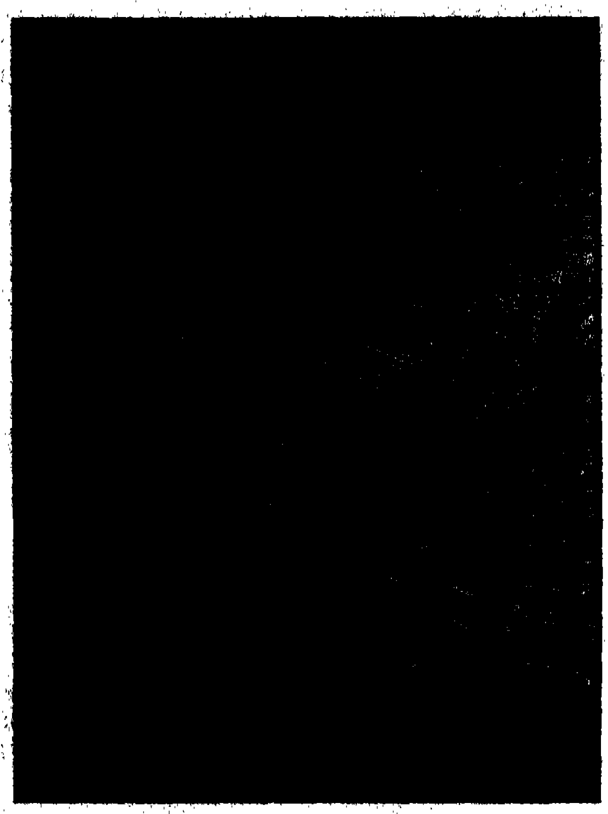

FIG. 2.

Photomicrograph of star-shaped bodies in very thin solidified oil film. × 40.

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Dielectric Constant and Conductivity of Soil at High Radio Frequencies

The significant part which the earth plays in the propagation of wireless waves has led to the urgency of finding out the electrical properties of soil in various states and at different high frequencies. Attempts have been made by quite a large number of investigators at several places in evaluating the dielectric constant and conductivity of the soil as from the knowledge of these one can obtain indirectly the attenuation of the signal travelling over it. Gish and Rooney[1] could determine more than a decade ago the conductivity of soil, though at a very low frequency. Subsequently, various other investigators including Strutt[2], Feldman[3], Ratcliffe and White[4] and Smith-Rose and Mc. Petrie[5] have measured the conductivity and dielectric constant by different methods. In India, Khastgir and Sen Gupta[6] have found the above constants very recently by the modification of the method adopted by Ratcliffe and White.

In all the experiments conducted so far the actual attenuation of the radio waves has not been directly determined by any laboratory method, though the knowledge of which is so essential in evaluating the electrical constants of soil. In the present investigation the attenuation of the radio waves travelling along a modified Lecher wire system immersed in the soil has been determined at frequencies of the order of 50 to 70 megacycles per second. The theory of the method consists in evaluating the value of the dielectric constant of a conducting medium and also its conductivity in terms of the attenuation constant of a radio wave travelling through the medium. From the standard analysis of the propagation of alternating currents along a pair of parallel wires immersed in a conducting medium it can be shown that,

$$K = \lambda_a^2 / \lambda_s^2 - \alpha^2 \lambda_a^2 / 4\pi^2 \quad \ldots \quad \ldots \quad (1)$$

and $\sigma = \alpha\omega\lambda_a^2/\lambda_s^2 4\pi^2 \quad \ldots \quad \ldots \quad \ldots \quad (2)$

where K = the dielectric constant of soil,

σ = the conductivity of the soil,

α = the attenuation constant,

ω = the angular frequency of the waves, and

λ_a and λ_s are the wavelengths in air and soil respectively.

In the present experiment λ_a/λ_s has been determined by the 'waveshift' method adopted by Smith-Rose and McPetrie[5] in a similar investigation. The attenuation constant α is found by the 'half-width' method adopted by Banerjee[7] in course of determination of radiation resistance of parallel wires. It is evaluated from the relation $\alpha = 2\pi d/\lambda_s^2$ where d is the 'half-width' which can be determined from the resonance curves, drawn along the length of the parallel wires. Knowing α and λ_a/λ_s, the values of the dielectric constant and conductivity can be easily determined.

The value of the conductivity measured was of the order of 10^6 e. s. u. It increases with frequency and moisture content. For dry soil the conductivity increased from a value of 1.5×10^6 e. s. u. to a value nearly equal to 2.6×10^6 e. s. u.

Unlike conductivity the dielectric constant diminishes with a rise of frequency but it increases with moisture content. It varied from a value of 4. 5 at a moisture content of 6. 3 % to a value of 17. 3 at a moistur content of 13·9 %. The attenuation constant is of the order of 10^{-8} e. s. u. but its variation is not very regular.

Generally it is higher for moist soil and higher frequency. The values of conductivity and dielectric constant are small as compared to the values obtained for English soils.

A detailed account of the present investigation will be published in the *Journal of the Benares Hindu University* very soon. The authors have great pleasure in thanking Prof. P. Dutt, M. A. (Cantab) for his interest and help in the work.

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10. 4. 37.

S. S. Banerjee.
R. D. Joshi.

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Effect of Vitamin C and Glutathione on the Growth of certain Micro-organisms

The relation of vitamin C to the growth of different kinds of animal and plant organisms has of late attracted some attention. We have in this connection carried out some experiments on the effect of vitamin C on the growth of certain fungi in a synthetic medium. The cultures used were those of *Aspergillus niger*, *A. oryzae*, *A. flavus*, *Saccharomyces cerevisiae* and *S. ellipsoideus*. The concentration of the vitamin used was 1 in 50, 000 in all cases. The inoculum for almost all the experiments consisted of 0. 1 c. c. of a suspension of a loopful of the culture (24 hours old) in 5 c. c. water. The estimations of growth were carried out by the determination of the dry weight in the case of *Aspergillus* and by counting in the case of *Saccharomyces*.

With all the varieties of *Aspergillus*, the addition of vitamin C in the medium resulted in very markedly increased growth during the first 72 hours; after 5 days, however, the total growth was approximately equal to that in the flask in which no ascorbic acid or ascorbic acid, which had been previously oxidized irreversibly, had been added. With *Saccharomyces* also addition of vitamin C markedly stimulated the growth, which was greater than that in the negative control even after 5 days. Parallel estimations of the vitamin C content of the cells have shown that it increases with the increase in growth.

Glutathione in a concentration of 1 in 50, 000 also produced a stimulating effect on the growth of all the *Aspergillus* organisms, mentioned above. The effect of added vitamin C cannot, therefore, be regarded as specific. There may be some relationship between glutathione and vitamin C in this question, which is being studied.

The proliferation of bacteria like *B. coli*, *B. subtilis*, *Aerobacter aerogenes* appeared, however, to be inhibited instead of being stimulated by vitamin C as found in preliminary experiments. In this respect the fungi, therefore, behaved very differently from the bacteria. The reason for this is obscure and the problem is under further investigation.

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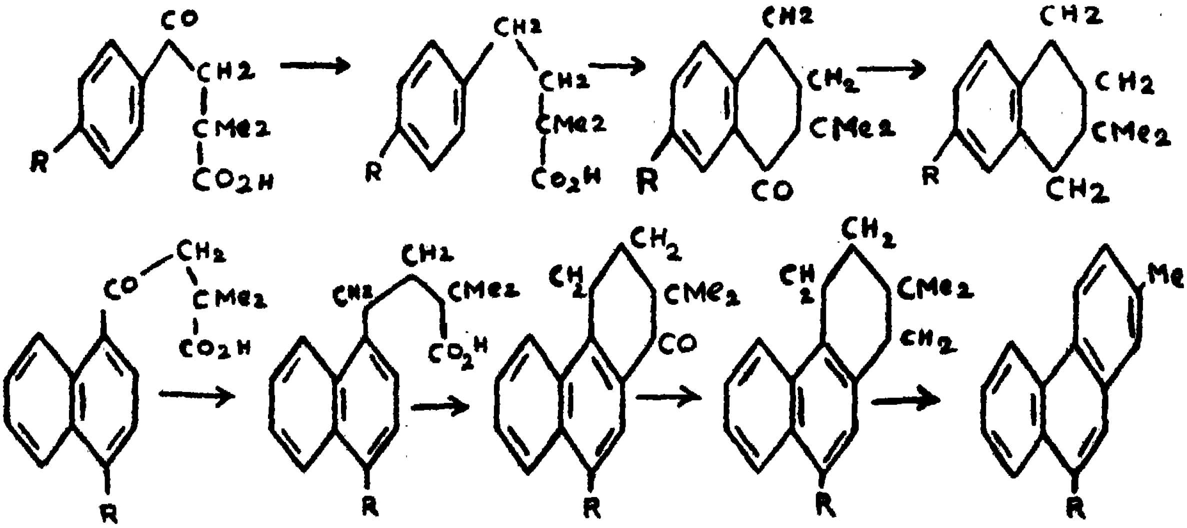
Action of Selenium on Carbocylic Compounds containing a gem-Dimethyl Group

In several previous communications[1] it was observed that spiro-hydrocarbons underwent ring transformation during selenium dehydrogenation at 300°-350°. The former investigation has been further extended and the action of selenium on hydroaromatic compounds containing a gem-dimethyl group instead of a spiro-ring has been studied. In view of a recent publication by Clemo and Dickenson[2], I like to place on record the results that I have obtained by the selenium dehydrogenation of 2 : 2- dimethyl and 2 : 2 : 7- trimethyl tetralin as also of 2 : 2- dimethyl-, 3 : 3- dimethyl- and 2 : 2 : 9- trimethyl-tetrahydrophenanthrene. It may be mentioned here that my results were communicated[3] to the Indian Science Congress in August 1936, which Clemo and Dickenson seem to have overlooked.

It was found that the two gem-dimethyl tetralins could not be dehydrogenated with selenium at 300°-340° to either naphthalene or alkyl naphthalenes whereas 2 : 2- dimethyl- and 2 : 2 : 9-trimethyltetrahydro-phenanthrene under similar conditions were converted into 2- methyl and 2 : 9-

dimethyl phenanthrene respectively. The 3 : 3- dimethyl compound however gave a mixture of hydrocarbons from which 3 methyl phenanthrene could not be isolated in a state of purity. The failure to dehydrogenate the two gem-dimethyl tetralins is rather curious, although 1 : 1 : 6- trimethyltetralin has been dehydrogenated by Ruzicka and Rudolph[4], using sulphur, and by Clemo and Dickenson[5] with selenium. In each case it was converted into 1 : 6-dimethyl naphthalene. Experiments are in progress which are likely to throw some light on this problem. The gem-dimethyl-tetralins and phenanthrenes were synthesized by the followin steps starting from as-dimethyl-succinicanhydride and benzene, toluene, naphthalene and methylnaphthalene. The keto acids first obtained by the Friedel Craft's reaction were reduced by the Clemmensen's method to the corresponding *aa*-dimethyl-*y*-aryl butyric acids, which were then cyclicized with 85% sulphuric acid. The tetralones and keto-tetrahydro-phenanthrenes thus obtained were reduced by the Clemmensen's method to the corresponding gem-dimethyl tetralins and gem-dimethyl tetrahydrophenanthrenes.



The author desires to express his grateful thanks to Dr J. C. Bardhan for his kind interest in this investigation.

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15. 4. 37.

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1. *J. Indian Chem. Soc.*, *11*, 389, 1934 ; *Proc. Indian Science Congress* 138, 173, 1935 ; *Current Science*, *6*, 295.
2. *J. Chem. Soc.*, 255, 1937.
3. *Indian Science Congress*, 1937, Abstracts, Section of Chemistry, p. 26.
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5. *J. Chem. Soc.*, 735. 1935.

Dehydrogenation of *gem* - Dialkylated Tetralins into Monoalkyl Naphthalenes

In the above communication it was observed that 2 : 2-dimethyl tetralin did not undergo dehydrogenation when heated with selenium under the usual conditions (compare also Clemo and Dickenson, *J. Chem. Soc.*, 1937, 255). This result was difficult to bring into line with the observations of Ruzicka regarding the formation of 1 : 6-dimethyl naphthalene from 1 : 1 : 6-trimethyltetralin. It is now found that 2 : 2 dimethyltetralin and 2 : 2-diethyltetralin smoothly undergo dehydrogenation when heated in a sealed tube with selenium at 300 - 320° for 24 hours with the formation of 2-methyl- and 2-ethyl naphthalenes respectively in excellent yields. These two hydrocarbons were identified by direct comparison with authentic specimens and by the mixed m. p. s of their picrates.

There can be little doubt that the dialkylated tetralins on account of their volatility do not come into intimate contact with selenium and therefore escape dehydrogenation when heated in an open vessel in the usual way.

The author desires to express his grateful thanks to Dr J. C. Bardhan for his keen interest in this investigation.

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Atomic Constants and Nebular Red-Shifts

In a recent issue of *Nature*[1] Professor Dirac has enunciated the general principle "that large numbers of the order of 10^{39}, 10^{78},.....turning up in general physical theory are, apart from simple numerical coefficients, just equal to t, t^2,.....,where t is the present epoch expressed in atomic units" (e^2/mc^3).

The above principle of Professor Dirac can also be expressed a little differently so as to show its connection with the red-shifts of the spiral nebulae, and without any reference to (hypothetical) quantities such as the 'age of the Universe', or current cosmological theories.

The law of the observed red-shifts is expressed in the form.

$$\frac{\Delta\lambda}{\lambda} = \frac{R}{K} \qquad \ldots .(1)$$

where $\Delta\lambda$ is the shift in wave-length λ for a nebula at a distance R, and K is a constant (of the dimensions of *length*) which observations show to be about $1{\cdot}7 \times 10^{27}$ cms. If we express this length, which is undoubtedly a fundamental cosmological constant, in a unit provided by the atomic constants, say e^2/mc^2 (*electron classical radius*), we obtain a number about $6{\cdot}0 \times 10^{39}$, *which is, apart from a numerical factor of the order unity, the same as the large number expressing the ratio of the electric to the gravitational force between an electron and a proton, i.e.* $\frac{e^2}{mMG}$ is of the order $2{\cdot}3 \times 10^{39}$. We may thus write

$$K/\frac{e^2}{mc^2} \quad \text{is of the order} \quad \frac{e^2}{mMG}$$

$$\text{or} \quad K \quad \text{is of the order} \quad \frac{e^4}{m^2Mc^2G} \qquad \ldots .(2)$$

We may express Dirac's principle in the form that all large numbers of the order of 10^{39}, 10^{78},.... turning up in general physical theory are apart from simple numerical factors, just K, K^2,.... where K is the fundamental cosmological length [defined by (1)] expressed in atomic units, and as such no reference is made to hypothetical quantities or cosmological theories.

Substituting the value of K given by (2) in (1), we have

$$\frac{\Delta\lambda}{\lambda} = \alpha \, . \left(\frac{m^2Mc^2G}{e^4}\right) R \qquad \ldots .(3)$$

where α is a simple numerical coefficient that can only be evaluated from a comprehensive theory of cosmology and atomicity. All the same, *as h does not occur in (3)*, we can say that the nebular red-shift is (very probably) a consequence of the classical (relativistic) electromagnetic theory and gravitation, and quantum theory would only introduce a correcting factor.

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22. 4. 37.

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1. *Nature*, *139*, 323, 1937.

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A Fuel Research Institute for India

In recent years the Government of India have taken an active interest in the investigation of the complex problems associated with the conversion of the raw materials of India into finished products. The Cotton Technological Laboratory at Bombay, the Lac Research Institute at Ranchi, the Institute of Sugar Technology at Cawnpore, the proposed Jute Research Laboratory at Calcutta, the Industrial Research Laboratory now located at the Government Test House at Alipore—all these indicate that the Government of India are keenly alive to the needs of industrial research.

There remains another major problem of industrial research to which the attention of the Government of India should immediately be drawn. The coal industry of India was responsible for the appointment of 1,70,000 persons in 1934 and the output was valued in that year at 6.3 crores of rupees. The series of mining disasters during the last two years have revealed faulty methods of mining; and a Coal Committee has been investigating for some months improvements in mining with a view to decreasing the possibility of accidents and increasing the percentage extraction from the coal seams, which now roughly stands at 50%.

The accounts of the proceedings of this Committee which have appeared in the Press do not indicate if the fundamental question of the proper utilization of second-class coal is being given the attention that it deserves. Dr Fox estimates a coal reserve of 20,000 million tons of coal lying within 1,000 feet of the surface, of which 4.500 million tons only are first-class coals, and of the latter only 1,700 million tons are capable of conversion into metallurgical coke. The average annual output now stands at 21 million tons of coal of which about 13 million tons are coking coals of good quality. It is necessary to consider seriously whether the coal reserves of India are being properly utilized and each variety of coal is being used for the purpose for which it has been best fitted by nature.

India is fortunate in possessing almost inexhaustible iron-ore deposits of the finest quality in the world. The iron-ore fields now being worked in the Behar and Orissa zone have a reserve of 3,000 million tons. According to modern metallurgical practices, 3,000 million tons of coking coal are necessary for the conversion of this ore-deposit into iron and steel; and it will be an extremely short-sighted policy to use up our reserve of 1,700 million tons of coking coal for any other purpose.

Unfortunately, out of the 13 million tons of coking coal raised every year, only 2 million tons, at the most liberal computation, are being used for metallurgical purpose, the rest being used for steam raising. Taking the long-range view—which only the Government of India can take and not the business men intent on immediate profits—the problem appears to be not only to improve mining methods with a view to increasing the percentage of extraction from 50 to 85, but also to lay down a definite policy which will ensure that each type of coal is used for the purpose for which it is most suited.

The Indian railways are now the largest consumers of coal in India. They are run on purely business lines in the matter of their fuel requirements. By far the greater portion of their needs is met by supplies of high-grade coking coals. Even the coal from Giridhi which is of extra-special quality due to its low phosphorus content is not spared. The vast deposits of high-grade iron and manganese ores in India naturally raise the hope that in near future we would be producing ferro-manganese for export, but the only coal available in India for the manufacture of ferro-manganese because of its low phosphorus content is now being rapidly wasted for steam raising. In America and Germany very inferior types of coal are now being tested for use in locomotives in the form of pulverized fuel. Many American engineers maintain that with the present developments as regards high boiler pressure, high superheat and multiple expansion of the steam, there is no reason why with the use of pulverized fuel, the over-all efficiency of the locomotive cannot at least be doubled in the next few years. At the International Conference on Bituminous Coal held in U. S. A. in 1931 the German engineers pointed out that in the Halle District of Germany pulverized fuel-fired engines were running on an alternate schedule with grate-fired engines, that this pulverized fuel was obtained from the low-grade lignites and brown coals, and that the comparative costs indicated that the dust-fired engine would produce a saving of $ 40, 000, *i. e.*, about its own value.

The consumers of coal, be they railways or private enterprises, will however demand that if the non-coking coals alone are to be used for steam raising, industrial research should be immediately undertaken with a view to inventing processes of treatment of inferior coals which will make the product more acceptable to industry. The fundamental problems of de-ashing the coal raised from Bengal, Bihar and Central India, of desulpharizing the coal raised from the tertiary deposits of Assam, of overcoming the technical difficulties of processes associated with the use of pulverized coal or coal in colloidal emulsion with heavy oil, can be tackled in a Central Institute of Fuel Research under the Industries Department of the Government of India.

In Germany similar problems are being investigated not only in research laboratories of private enterprises and of the universities but also in the magnificent laboratories of the Kaiser Wilhelm Institute for coal research at Mullheim. In Japan the Imperial Fuel Research Institute, Saitama-Kawaguchi, and the technological laboratories of the universities are engaged in very thorough investigations on the technical possibilities of the coal-dust engine and the conversion of coal into oil.

In the United Kingdom fundamental investigations relating to the utilization of the fuel resources have been entrusted to the Fuel Research Board established in 1917 by the Committee of the Privy Council for Scientific and Industrial Research.

After careful consideration of the whole fuel problem from the broadest point of view, this Fuel Research Board adopted as their programme two lines of research, *viz.*,

(*i*) A survey and classification of the coal seams in the various mining districts of the United Kingdom by means of chemical and physical tests in the laboratories.

(*ii*) An investigation of the practical problems which must be solved if any large proportion of the raw coal at present burned in its natural state is to be replaced by the various forms of fuel obtainable from coal.

The Government of India have set up a Coal-grading Board with a view specially to classify the coals meant for export. It is desirable that the Coal grading Board should be enlarged and transformed into a Fuel Research Board; and that adequate funds should be placed at the disposal of this Board for conducting researches on the complex problems that must be solved in order that Indian coals may be better utilized.

Long-Range Forecasting of the Southwest Monsoon and Everest Expeditions

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Introduction

EVEREST is guarded by violent winds and intense cold and in addition, if the winds aloft happen to be weak, fresh falls of snow often render the slopes of the summit dangerously slippery for days together. Consequently, for a surprise attack on the peak, a season must be chosen when the temperature is not too low and the wind neither too strong nor too weak. On account of these limitations, the final assault has hitherto been confined to the beginning of the Tibetan summer, *i. e.*, between May and June. Apart from the formation of cyclones in the Bay of Bengal and the Arabian Sea, the choice of this season has two serious drawbacks, *viz.*, the imminence of the southwest monsoon and the rather high frequency of the western disturbances in some years. The mountaineers, therefore, have to depend very largely on luck in regard to fresh falls of snow and the rapid falling off of the prevailing westerlies.

An expeditionary party generally proceeds to the Himalayas early so that the members may have ample time for slow acclimatization, a process so very necessary to the difficult climbing operations above 25, 000 feet level. The Everesters, therefore, naturally like to begin their campaign with some degree of confidence as to the weather ahead. A reliable long-range forecast of the establishment of the monsoon, if it could be supplied, would certainly be a very welcome addition to the elaborate equipment necessary for these undertakings. It is generally by the end of February that the meteorologist is called upon to furnish informally a prediction of the probable date of the establishment of the monsoon. In other words, the forecast has to be supplied about four months before the normal date of the establishment of the monsoon. A prediction of this type is certainly a scientific gamble, particularly when it is remembered that there are as yet no known rules for drawing up a long-range forecast of this type. Nevertheless, since 1930, the author has, from time to time, been asked to give mountaineers his anticipations regarding the prospects of the pre-monsoon and post-monsoon weather and also of the monsoon. Reports subsequently received from the parties concerned, on the accuracy of the predictions of the average character of the weather in the periods in question, have by no means been disappointing. This article is but a modest venture at nothing more than outlining the process in which it was to make the best use of the available data, and which has so far achieved fairly satisfactory results.

As regards the monsoon, it may be worthwhile to note down the salient points of a protracted analysis of the daily weather charts during December, January, and February, leading to forecasts of the desired type. The method which is proposed to be discussed in the following paragraphs may, in favourable circumstances, only indicate an early, normal or late establishment of the monsoon over Northeast India. The results, therefore, are still more qualitative than quantitative, and further tests are in progress.

The advance of the Southwest Monsoon

The monsoon has two limbs over the seas, *viz.*, the Bay of Bengal and the Arabian Sea branches. In India, systematic meteorological records exist only for about half a century. In the circumstances, we have to turn to the Sanskrit literature in search of appropriate references to the monsoon. Fortunately there is a classical poem, the chief topic of which is the monsoon and its progress through the country. It is the famous *Meghduta* or the "Cloud Messenger" by Kalidasa written about fifteen hundred years ago. The descriptions of the monsoon clouds and other phenomena over northern India and the Himalayas as given in this book are surprisingly similar to those of the modern mountaineers. To cut a long story short, we shall only give an account of that portion of the story which is relevant to the present topic.

An exile from Aloka (a city in the western Himalaya, near modern Gartok), confined at Ramgiri (near modern Nagpur), saw the possibility of a communication with his beloved at Aloka through the agency of the drifting clouds at the advent of the monsoon. The poet gives minute directions to the clouds, travelling from Ramgirj to Aloka, with a long list of stops, varying speeds and cautions as to the detours over the plains of northern India. The peculiarities of the cloud path from Ramgiri to Aloka, a distance of over one thousand miles, as visualized in the *Meghduta*, is no mere fantasy even from the point of view of the modern weather charts. We can therefore conclude that, in ancient times, the motion of the low clouds from east or southeast on a vast scale over northern India was regarded as the criterion of the establishment of the monsoon. Moreover, the descriptions of the progressive westward travel of the misty conditions and of rainsqualls from Ramgiri towards Aloka, as given in the various stanzas of the poem, are suggestive of the weather associated with the westward or "retrograde" motion of the monsoon depressions. Again the exile at Ramgiri is said to have taken the first opportunity of sending his message to Aloka by the agency of the easterly clouds. It may, therefore, be correct to presume that, approximately two thousand years ago, the burst of the monsoon over northern India was virtually taken to synchronize with the formation of the first monsoon depression in the north of the Bay of Bengal.

In modern times, the monsoon is regarded as a vast oscillating and pulsating phenomenon. Its advance from the equatorial region northwards in the hot season and subsequent retreat from the country in the autumn, unless accelerated by disturbances, is on the average a gradual and rhythmic process. Both these periods are characterized by the presence of two moist air sectors, normally, one over the Peninsula (approximately the portion of India south of latitude 20°N.) and the other over the eastern half of the Bay of Bengal.* The dates of the advance and retreat of the monsoon at the surface, as provisionally recognized†, is given in Fig. 1 basis of which is however rainfall, which is certainly not a very trustworthy criterion in all regions. It suggests that the advance of the monsoon is a much quicker process than its retreat. The corresponding diagram for the upper levels would show a considerable lag in the dates.

The sailors in the Indian waters talk of the setting in of the monsoon when they meet with strong southwesterly winds, rough seas and showers. For the aviator, the monsoon is apparently heralded by the advent of low clouds over large tracts of the country and a general weakening and veering of the westerlies at moderate levels over the greater part of the Indian region and locally heavy rainsqualls along the Burma coast. A layman in northern India, on the other hand, may easily be deceived regarding the establishment of the monsoon, if by the end of the hot season, general bad weather, associated with overcast skies, fitful drizzles and intermittent rain with a persistent easterly slant, punctuated by heavy thunderstorms, continues for a few days. This is the *Chota Barsat* or the little monsoon and, as the name suggests, it is a marked but temporary advance of the monsoon.

From the point of view of the forecaster who aspires to predict the date of the arrival of the monsoon, unfortunately none of these pictures

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*Cf Table 1 for frequency of storms in the Arabian Sea and the Bay of Bengal. The tendency for formation of long troughs in the sea areas in the pre-monsoon and post-monsoon months is also well known.

† According to criteria worked out by Basu S, Iyer V. D. and Savur S. R.

provides a sure criterion for the establishment of the monsoon over the plains, not to speak of the criteria which may satisfy the Everest climbers. The meteorologist has, therefore, to strive to get a definition bereft of all accidents. Let us now see whether a specification acceptable to both the layman and the professional may be drawn up.

The specification of the Monsoon for Northeast India

It is chiefly on account of the marked thunderstorm activity over Northeast India in May and June that the rainfall can never be a clear criterion for the establishment of the monsoon over that region. The storm tracks in the Bay of Bengal show that appreciable retrograde motion of cyclones is seldom noticed in April, while in May the same remark holds above Lat. 18°N. In June, however, an abrupt change appears and the majority of the cyclones not only originate to the north of Lat. 18°N. but also move in a retrograde direction. This sudden transition between May and June is a definite event and is associated with the more or less permanent seasonal backing of the upper winds over Bengal from southwest to south and southeast. The most important condition, therefore, is that the average depth of the southerly current should not be less than 2 Km. during undisturbed weather. The boundary effect of southerly winds of this average thickness blowing against the eastern Himalayas generally brings into existence a sort of deformation field and the southeasterly branch of the monsoon current proceeds up the Gangetic plain and the southwesterly branch to Assam. This criterion appears to be a suitable one for uniquely fixing the date of the establishment of the monsoon over Northeast India, independently of the rainfall.

The identity of the Monsoon Current

From a study of the monthly normals, it is seen that, between April and May, a certain steadiness appears in the dry and wet bulb temperatures in the extreme south of India and the former begins to fall in the equatorial belt. From May onwards, a progressive fall in both the temperatures commences in the south and the two waves of temperature-fall practically sweep the whole country by the end of August. The fall of the wet bulb temperature is feeble and the wave travels much slower than the one of marked dry bulb fall. It may also be recalled that the first spell of widespread rainsqualls over Ceylon in May is supposed to herald the entry of the monsoon in the Indian area.

These facts appear to suggest that the monsoon advances at the surface as a cold front[1] in relation to the bottom layer of the hot continental air outside Northeast India. In the circumstances, the magnitude of scale of interaction between the southern winter and the northern summer may be determined only after eliminating the purely seasonal effect in the same air mass. For the present, however, the causes of the monsoon may be sought in the Northern Hemisphere in general and the Indian region is particular.

The Principal Air Masses in India

The various air masses over India have already been classified in the chapter on "Himalayan Meteorology" in Ruttledge's *Everest 1933*. A recapitulation in a slightly different form and with something by way of an addition may not be out of place here.

The general circulation of the atmosphere over the Northern Hemisphere is depicted as a large belt of westerlies round the North Pole, whilst another great belt of easterlies prevail over the equatorial region. In the northern winter, there is a southward advance of the westerlies into Extra-Tropical India (*i. e.*, roughly northern India and Upper Burma) and in the hot season an incursion of the easterlies takes place in the same region.

(*a*) *Himalayan Air*—For the Indian region, the Himalayan air may be conveniently divided into two branches, *viz.*, (*i*) the western Himalayan air having a northerly or northwesterly trajectory over the greater part of India and (*ii*) the eastern Himalayan air having a northeasterly or easterly trajectory over Northeast India and Burma. With the progress of the seasons, the lower layers, at any rate, of the western Himalayan air, undergo large temperature variations as it flows down the vast Indian plains. The eastern Himalayan air, on the other hand, is better able to retain its identity as a cold current in the bottom layers by flowing into the Bay of Bengal along comparatively shorter routes across the plains of Bengal and Burma.

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[1] *Ind. Met. Dept. Sc. Notes*. Vol. III, No. 19, Ghosh U.N

(*b*) *African Air or the Westerly Drift*[*]—This current brings in dry and warm air across Arabia and Persia in westerly trajectories apparently originating sometimes over the Sahara region. With the advance of the western disturbances[†] there is a shift of the trajectories to southwest and this air mass becomes more and more moist in the lower layers as its fetch over the Arabian Sea increases. It also becomes moist in the upper layers through its contacts with the equatorial air. In the upper levels the air often penetrates as far as the Bay of Bengal and Burma in the rear of the western Himalayan current.

(*c*) *The Equatorial Air*—The easterly circulation over the equator, which is the storehouse of heat and moisture, may be called the equatorial or the tropical current. In the pre-monsoon and post-monsoon months, the offshoots from this current in their northward incursions mix, mainly in their bottom layers, with patches of the old land air over the Bay of Bengal or the Arabian Sea. In "Himalayan Meteorology"[2] this mixture was described as the Bay and the Arabian Sea air respectively.

The air mass (*a*) and the portion of (*b*) having westerly trajectories, *i. e.*, flowing over land areas mainly, may be called the continental air and (*c*) along with the portion of (*b*), having southwesterly or long trajectories over the sea areas, *maritime air*.

The prognosis of the Monsoon

The approach of the western disturbances, especially of those which travel eastwards north of Kashmir, shows how the African air acts as the drying agent particularly over Northwest India in the retreating monsoon period. From September onwards, the passing away of the disturbances across the same region ushers in winter conditions over Northwest India. The process goes on and the flow of the western Himalayan current is further augmented by the formation of cyclones in the sea areas until stable winter conditions are established over the whole of India and Burma. Fig. 2, which is self explanatory, represents more or less the undisturbed winter disposition of the western Himalayan and the equatorial currents from the surface up to 6 Km. with a stationary discontinuity separating them. It is seen that in the winter, by *far the most dominant* air mass over the Indian region is the western Himalayan air. The story of the gradual destruction of this air mass, below 10 Km. or so, with the progress of the hot seasons, ought to provide a clue to the following monsoon.

For the Bay of Bengal branch of the monsoon to advance in one great sweep from Burma up the Gangetic plain, or the Arabian Sea branch from Malabar-Konkan into Gujarat and the central parts of the country, the western Himalayan air has to be pushed away westwards. The beating back of the Himalayan air, however, has to be an intermittent process, giving rise to marked spells of thunderstorms over the country during the hot season, often synchronizing with the formation or passage of disturbances.

The destruction of the Western Himalayan Air

By the end of January, a "film" of the western Himalayan air covers the greater part of the country. It is a stratified layer about 0. 5 Km. in thickness and is built up slowly from September onwards, chiefly through the katabatic process. From the beginning of the hot season, there is a gradual rise in the dry and wet bulb temperatures and the film thus loses its stratification. The stratification in the upper layers, however, is generally broken up more easily than at the bottom, because air at these levels is brought in by widely different trajectories throughout the year.

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[*] In Himalayan Meteorology the expression was used in a different sense.

[†] The western disturbances either originate in the southern European area and travel eastwards through Iran to the Indian region or form locally in Northwest India mostly over Sind and Baluchistan in the hot season. They are of two types, dry and wet. The latter type, giving moderate to heavy *rainfall*, draws its moisture from the equatorial current even in the winter.

2. *Everest 1933*, published by Hodder and Stongton Ltd, 1934.

The western Himalayan current has three weak configurations, *viz.*, (*i*) the foot of the Himalayas where surface conditions extend to considerable heights and warm and moist air having access to the sub-Himalaya tends to remain there, (*ii*) the deserts of Sind and Rajputana the heating effect of which spreads, and (*iii*) the central parts of the country over which it habitually diverges. A vigorous and sustained attack of the African air or the equatorial air delivered at any of these places is likely to undermine permanently the persistency of the western Himalayan current. Any lag in the seasonal heating and addition of moisture may be made up, or the rates accelerated beyond the normal, by disturbances. From the end of the winter the passage of the western disturbances or the formation of cyclones in the sea areas generally brings about any of the following changes:

(*a*) The establishment of the African current causing a marked and widespread heating of both the western Himalayan and equatorial currents.

(*b*) The incursions of the equatorial into the western Himalayan air over the central parts and often as far north as the Punjab or the United Provinces, across the east coast of India. The subsequent veering of the former while withdrawing into the Bay of Bengal adds heat and moisture to the entire length of the latter flowing over the Gangetic plain. It is usual for (*b*) to follow (*a*).

The upper and lower limits and the most frequent occurrences of the various disturbances may now be set out as in Table 1.

It need hardly be mentioned that the frequency of the disturbances in a year is hardly a measure of the disturbed condition in that year. In any case, from the point of view of long-range prediction of the establishment of the monsoon in Northeast India, the only redeeming feature is that the variability of the weather in the Bay of Bengal is not so great from March to May as between June and November*.

Interaction between the Himalayan and the Equatorial currents in the hot season giving birth to the Monsoon

In order to study the interaction of the three principal air masses, a knowledge of the seasonal temperature and humidity of each in the various levels is essential. In the absence of more or less simultaneous meteorograph ascents at different places between the Equator and the Himalayas, it is difficult to produce direct evidence as to the respective properties of the three air masses. For the purposes of this paper we may confine our attention to the transformation of the equatorial current. Let us attempt a rough mental picture of the virtual temperatures at the several levels of the two air masses in the winter and summer.

It may be noted here that there are a few meteorograph ascents generally supporting the data set out in Table 2. The temperatures given merely contemplate the contrast which may exist between the equatorial air over the Andaman Sea and Blandford's thermal focus.

Divergence—Without going into details, it may briefly be stated that a critical examination of the charts of the distribution of upper winds in each level shows that the daily changes in the various meteorological elements and the weather can best be explained if it is assumed that any two currents tend to diverge at the line of discontinuity between them, provided there is a considerable direct opposition between the two air movements, thus bringing a deformation field into existence.

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*This includes the epoch of the greatest variability in the Bay of Bengal, *viz.*, July to September, chiefly owing to the formation of feeble cyclonic circulations over land and sea.

Table 1. Frequencies of disturbances in the Indian region.
(Period 1891-1935).

Frequency	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
				WESTERN DISTURBANCES * (in the neighbourhood of Northwest India)									
Maximum	9	8	9	9	8	5	5	3	5	7	6	11	56
Minimum	1	2	2	1	0	0	0	0	0	0	0	0	7
Most frequent	4	5	4	5	0	0	0	0	0	0	3	4	26
				BAY OF BENGAL CYCLONES (including feeble cyclonic circulations over sea and coast)									
Maximum	1	0	1	1	2	4	5	5	5	4	4	2	19
Minimum	0	0	0	0	0	0	0	0	0	0	0	0	8
Most frequent	1	0	1	1	1	1	2	2	2	2	2	1	14
				ARABIAN SEA CYCLONES * * (including feeble cyclonic circulations over sea and coast)									
Maximum	1	0	0	1	2	2	1	1	2	2	3	1	6
Minimum	0	0	0	0	0	0	0	0	0	0	0	0	0
Most frequent	0	0	0	0	0	0	0	0	0	0	0	0	2

* The statistics for western disturbances are necessarily incomplete. Moreover there have been changes in the practice of counting the disturbances from time to time

* * Excluding western disturbances travelling over North Arabian Sea.

Table 2. Virtual temperatures in degrees Fahrenheit of pure air masses assuming uniform lapse rates (hypothetical).

Air Masses	Winter						Summer					
	Surface	Height in Km. above M. S. L.					Surface	Height in Km. above M. S. L.				
		1	2	3	4	5		1	2	3	4	5
Equatorial	80	72	64	56	48	40	85	77	69	61	53	45
Western Himalayan	60	49	38	27	16	5	98	83	68	53	38	23

LONG RANGE FORECASTING OF THE SOUTHWEST MONSOON

Some beautiful examples of symmetrical and divergent stream lines* in the two air masses, western Himalayan and the equatorial, are to be found in the winter charts, particularly for the moderate levels. In the event of any largescale and direct opposition being established, the western Himalayan air diverges into two main currents, *viz.*, the northeasterly and northwesterly. The equatorial current, on the other hand, is split into two branches, *viz.*, the northeasterly and the southwesterly. This remark applies to discontinuities between the air masses at the surface and the upper levels, wherever there is opposition. The extent of the development of each of the four limbs in the various layers evidently depends on many factors. It may, however, be pointed out that the mean seasonal position of the line of discontinuity in the various layers ought to determine the regional prevalence of the southwesterlies and northeasterlies. In March, for example, we may suppose that the mean line of discontinuity runs approximately, say, from Ceylon to lower Burma. We can then imagine a shift of this line bodily northwestwards between March and May, with a suitable anticlockwise rotation, superimposed on the motion of translation, until the line of discontinuity stretches from somewhere in Assam right into the Arabian Sea, thus eventually establishing the southwest monsoon over the Indian region. In actual practice, however, the sinuosities of the lines of discontinuity in the western Himalayan current has to be considered.

Monsoon origin and the Transition Layer—It is clear from the preceding paragraph that a sustained convergence between the western Himalayan and equatorial currents in the bottom layer is necessary, so that the southwesterly limb of the latter can grow steadily from month to month. Table 2 shows that the equatorial air is hotter than the Himalayan air in the winter at all levels and this contrast persists in the summer above a certain level, which may be called the transition layer*. The height of this layer above a certain place increases with the advance of the hot season (*Vide* Table XII, "Himalayan Meteorology"). It is clear that below this layer there would be an incursion of the equatorial into the heated western Himalayan air, thus giving rise to a persistent convergence mainly in the bottom layer of the two air masses. The point at which the axes of the deformation field cut may be called the *monsoon origin.* It usually lies over Hyderabad and the Central Provinces between May and June and then moves northwestwards. Once the convergence is established the equatorial current develops two branches, *viz.*, the southwesterly and the southeasterly. The former extends from the Central Provinces to Assam and is prominent normally from February onwards.

The "burst" of the monsoon indicates a rapid lifting of the transition layer accompanied by a general shift of the winds below to the southwest, the lift being much greater over the Peninsula, Burma and Northeast India than over the rest of India. This sudden change may occur at any time between May and July and hence the variability in the date of the onset of the *Chota Barsat* and that of the establishment of the monsoon.

Climatological evidence

It is interesting to note that sometimes, from the usual surface climatological data, such as the departures from normal of the mean maximum and minimum temperatures and of regional rainfall, etc., at the end of winter or the beginning of summer, the subsequent hot weather mechanism of the advance of the monsoon can be anticipated if due precaution is taken in the interpretation of the data along with the average upper wind trajectories.

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* Generally fog, cloudiness or thunderstorms occur along the axis of extension.

* The intensity and direction of movement of a cyclone appear to depend on the height of the transition level in the neighbourhood. The motion of cyclones in summer and autumn appears to be retrograde if the centre is in the southeasterly or northeasterly branch, and normal if the centre is in the southwesterly branch of the equatorial current. The "see-saw" character of cyclones forming in Bay, in quick succession, may also be explained in this way.

By February or March the dominance of a given air mass over a region may be recognized on the monthly climatological charts as follows :—

(*a*) *The Himalayan air*—by a significantly lower maximum and minimum temperature than the normal over practically the whole of the Indian region.

(*b*) *The Equatorial air*—by a significantly higher minimum than the normal over the region roughly to the north of latitude 16°N.

(*c*) *The African air*—by a significantly higher maximum and minimum than the normal chiefly over northern and central India, particularly the hill stations.

With the progress of summer the criterion (*c*) also applies to the surface where overheated western Himalayan air mixes with the equatorial.

The Comparison of a year of early Monsoon with that of a late Monsoon

As the hot season advances, the moist wind sectors over the Peninsula and the Bay merge into one with the growth of the southwesterly branch of the equatorial current and the decay of the western Himalayan air tongue protruding out into the Bay. This large moist wind sector has an east to westward oscillation and if this movement is pronounced then there may be an early advance of the monsoon into Bengal. The associated depth of the monsoon current and precipitation, however, may not be such as to interfere too much with the work of the expeditions to the eastern Himalaya until the first monsoon depression develops in the northeast angle of the Bay.

A concrete example of the use of the various criteria may now be given. As a representative year of an early monsoon and that of a late monsoon from the point of view of the Everester, the years 1933 and 1935 respectively have been chosen. For the present this is all that can be done in the absence of normals of upper air data. According to the existing criterion of rainfall the monsoon was established in Bengal on the 22nd May in 1933 and on the 20th June in 1935. In order to illustrate the difference between the two years as briefly as possible, the mean monthly winds[3] at 1 Km. for the two Februaries and at 6 Km. for the two Junes have been plotted in Figure 3 (axis of extension not shown) which is self-explanatory. In the diagram, the data of the departure of the mean minimum temperature from the normal and also that of the mean minimum in February 1933 and 1935 respectively for each station have also been plotted. The maximum temperature data are shown in the appropriate 1 Km. charts for the two Februaries and the corresponding minimum temperature data in the 6 Km. charts for the two Junes for the sake of economy in diagrams. The regions, in which rainfall was higher than normal in each of the months are shown as hatched areas. These regions of excessive rainfall generally support the more or less idealized trajectories drawn. It may be mentioned that both in 1933 and 1935 the several trajectories of the winds at each level, as shown in the diagram, have also the support of the daily analysis of charts. Moreover, the net climatological effect of February 1933 are : (*a*) An appreciably higher maximum in the whole of the submontane region. This shows that, as soon as a deformation field appeared in the tropical air over Northeast India, in May the southeasterly branch could easily advance northwestwards and strike at the source of the western Himalayan air. (*b*) The markedly higher minimum temperatures in the central parts of the country, as compared with the corresponding data for February 1935. This shows the dominance of the equatorial air over the central parts of the country as early as February. The chart of upper winds at 1 Km. for February 1933 unmistakably shows that there was a marked incursion of the equatorial current into the central parts of the country that year. Moreover, the southeasterly branch of the incursion tended to penetrate Rajputana across the Vindyas. These facts suggest that in 1933, with the progress of the hot season, the western Himalayan tongue

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[3] Resultant direction of wind and mean speed regardless of directions, vide *Upper Air Data* of the Ind. Met. Dept. Vol. VI, Part 13, 1933, Vol. VII, Part 13, 1935.

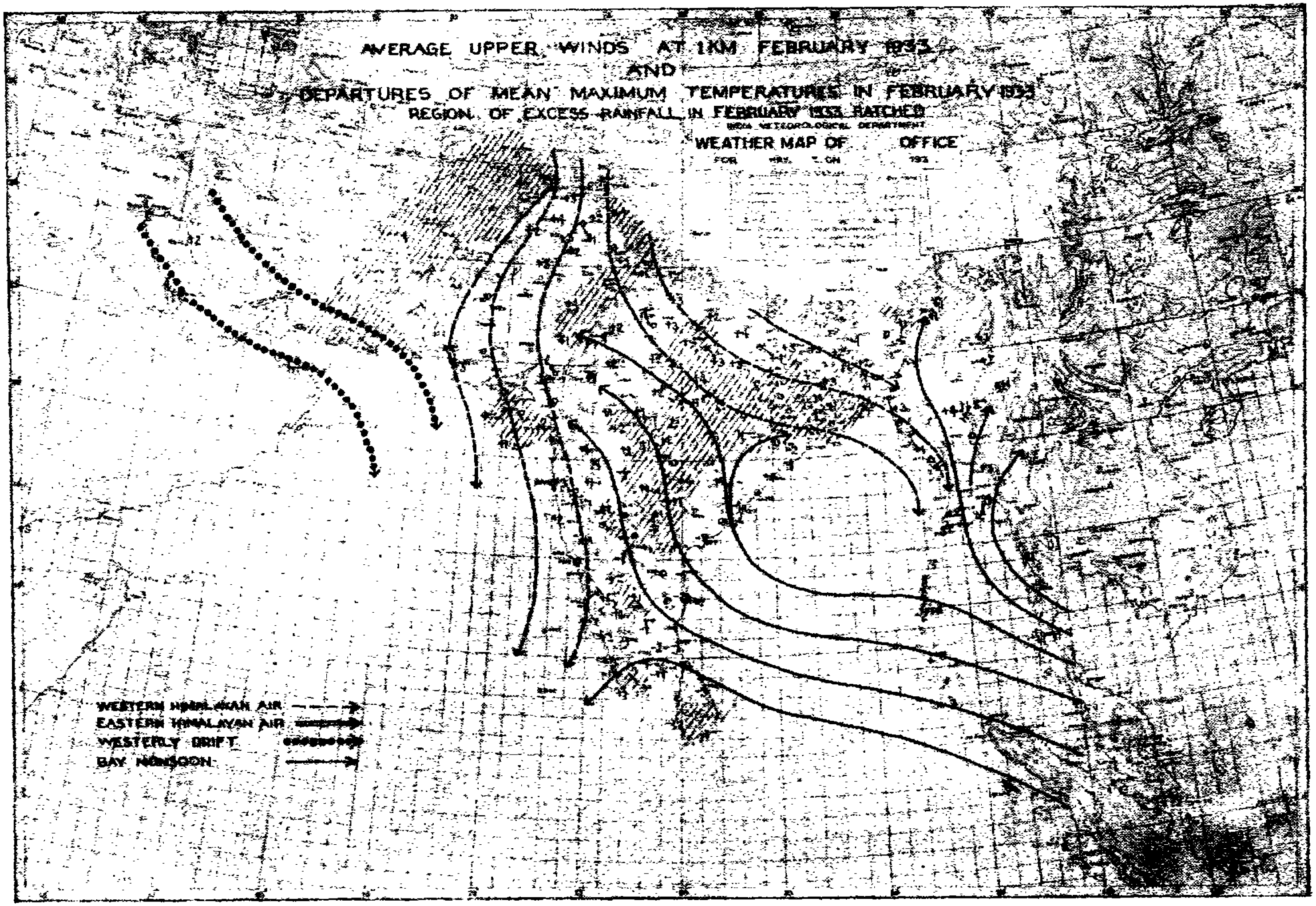
AVERAGE UPPER WINDS AT 1KM FEBRUARY 1933
AND
DEPARTURES OF MEAN MAXIMUM TEMPERATURES IN FEBRUARY 1933
REGION OF EXCESS RAINFALL IN FEBRUARY 1933 HATCHED
INDIA METEOROLOGICAL DEPARTMENT
WEATHER MAP OF OFFICE
FOR HRS. ON 193
WESTERN HIMALAYAN AIR
EASTERN HIMALAYAN AIR
WESTERLY DRIFT
BAY MONSOON

Fig. 3 (a)

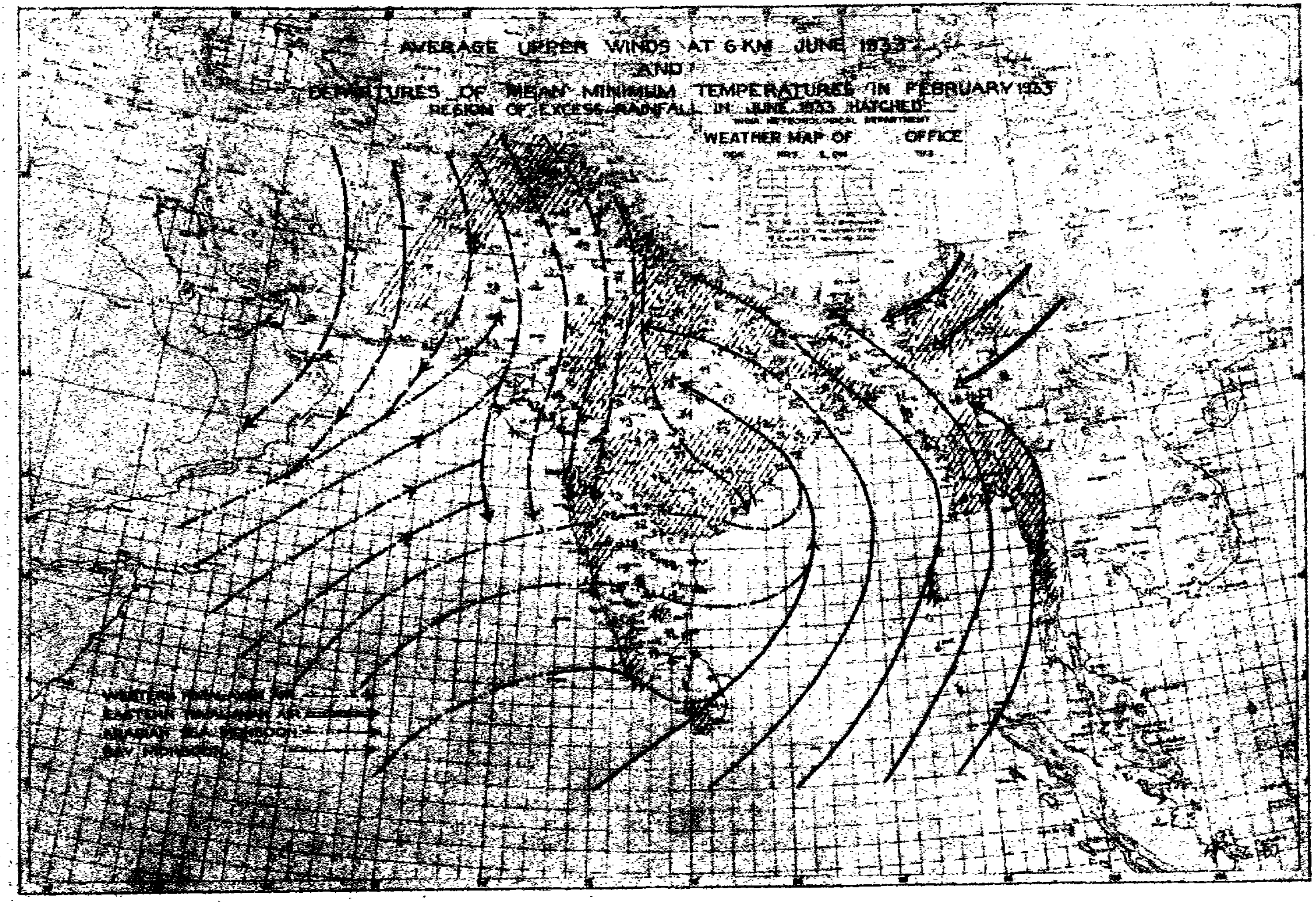
AVERAGE UPPER WINDS AT 6 KM JUNE 1933
AND
DEPARTURES OF MEAN MINIMUM TEMPERATURES IN FEBRUARY 1933
REGION OF EXCESS RAINFALL IN JUNE 1933 HATCHED
INDIA METEOROLOGICAL DEPARTMENT
WEATHER MAP OF OFFICE
WESTERN HIMALAYAN AIR
EASTERN HIMALAYAN AIR
ARABIAN SEA MONSOON
BAY MONSOON

Fig. 3 (b)

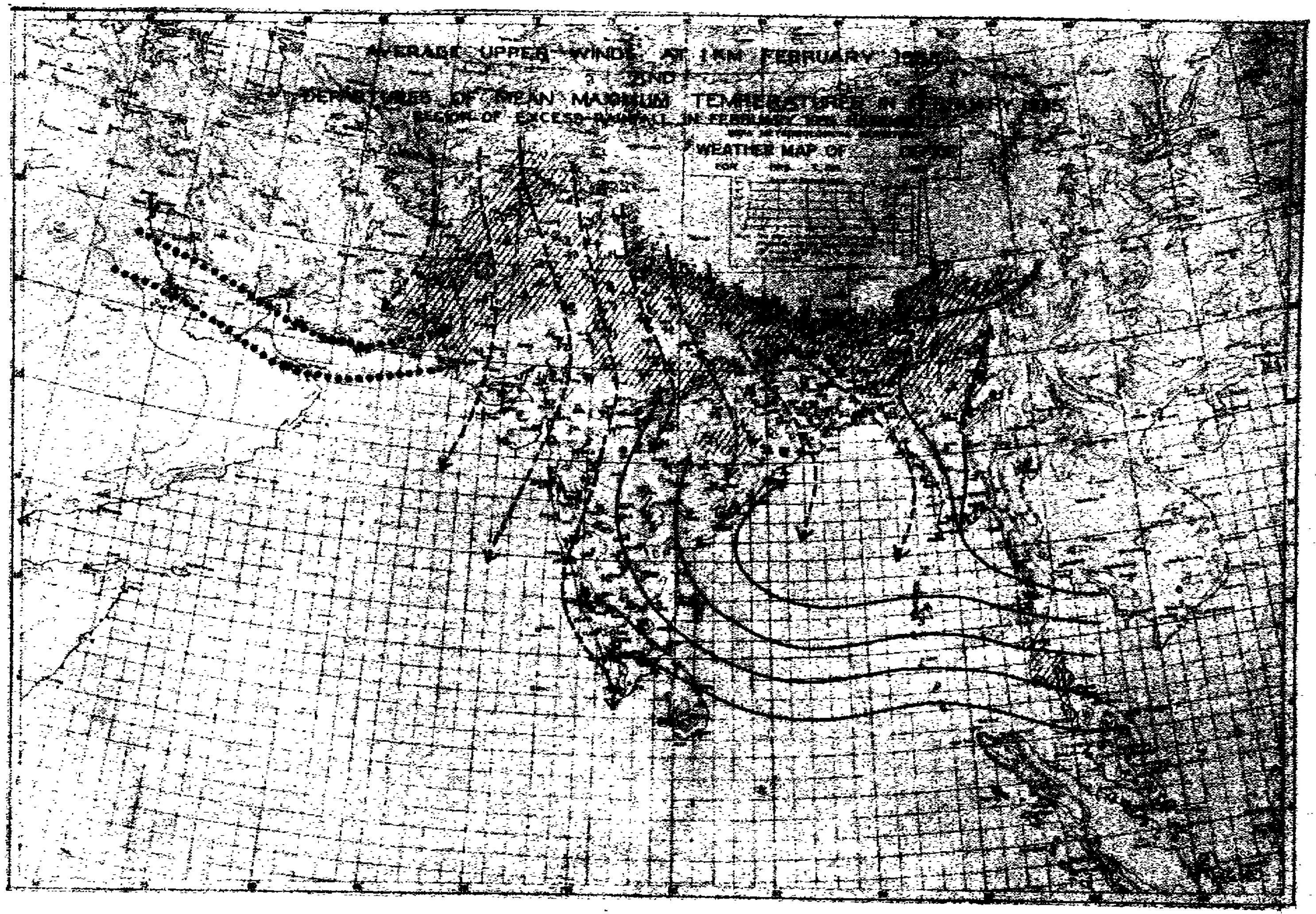
AVERAGE UPPER WINDS AT 1 KM FEBRUARY
AND
DEPARTURES OF MEAN MAXIMUM TEMPERATURE IN FEBRUARY
REGION OF EXCESS RAINFALL IN FEBRUARY
WEATHER MAP OF

Fig. 3 (c)

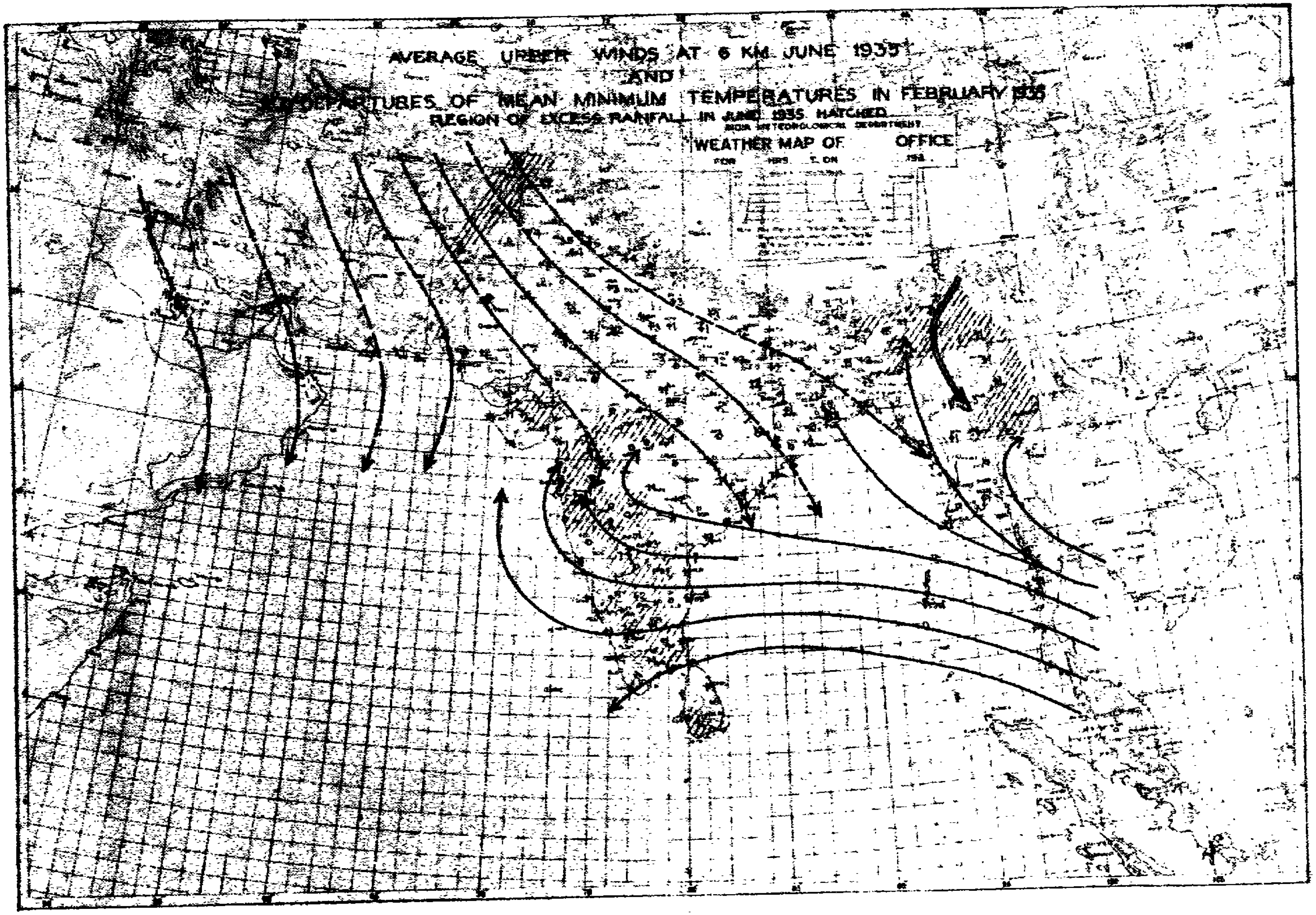
AVERAGE UPPER WINDS AT 6 KM JUNE 1935
AND
DEPARTURES OF MEAN MINIMUM TEMPERATURES IN FEBRUARY 1935
REGION OF EXCESS RAINFALL IN JUNE 1935 HATCHED
INDIA METEOROLOGICAL DEPARTMENT
WEATHER MAP OF OFFICE
FOR HRS. I.S.T. ON 193

Fig. 3 (d)

was caught in the southeasterly branch of the advancing equatorial air and hence the transition height grew rapidly over the Gangetic plain bringing in an early monsoon. These features were entirely absent in the corresponding chart for February 1935. The most remarkable difference, however, is to be found in the trajectories of the equatorial current in the 6 Km. charts for the two Junes. In June 1933 the growth of the tropical air to the phenomenal height of 20,000 ft over the Gangetic plain effectively brings out the character of the abnormally early monsoon that year, for the Everesters.

It should be pointed out that long-range forecasts of the time of establishment of the monsoon over the Everest region, based on this method of analysis, may not be fulfilled owing to any of the following causes arising in the hot season:—

(*i*) Unseasonable outbursts of the western Himalayan current in the shape of cold waves from the Northwest Frontier to the head of the Bay of Bengal thus lowering the transition layer.

(*ii*) Frequent outbursts of the African current in the shape of heat waves, which being "sandwiched" between the western Himalayan and the equatorial currents, heats up both. This current is usually refused admission into the Indian region by the characteristic veering of the westerlies over Northwest India on the eve of the monsoon.

(*iii*) An outburst of the eastern Himalayan current in April and May giving rise to a large number of cyclones in the Bay of Bengal, if the *swaying balance*[4] between this and the equatorial is lost frequently.

(*iv*) An outburst of the equatorial current associated with disturbances outside the Indian region.

From the point of view of long-range forecasting, however, all these factors of uncertainty need not arise in any particular hot season.

The method of forecasting developed in the preceding paragraphs requires that the effects of the repeated onslaughts of the equatorial and the African currents (or westerly drift) should be carefully studied from September onwards to determine the life-history of the building up of the continental air mass over India during the winter. If the average wind structure of each month is known, say up to 6 Km., then the "stock-taking" by the end of winter, *viz.*, February* seems appropriate, this being the only month singularly free from cyclones. We can then form a rough idea of the proportion of unmixed western Himalayan air and its boundary in the enormous continental air mass built up over India. During each spell of disturbed weather from February onwards, the lines of discontinuity in the various levels give a good indication of the extent of undermining of the western Himalayan air and of its subsequent recovery. The cyclone tracks in April and May also supply similar information. A surer and much less arduous method of daily survey over the country would certainly be an inexpensive determination of (*a*) temperature aloft, (*b*) pressure lapses at least in the first two kilometres, and (*c*) the growth of the height of winds from a southerly direction above ground.

Chota Barsat—There is a special climatic peculiarity of Northeast India, which may give rise to some misunderstanding as to the establishment of the monsoon. In some years, the month of May, generally in the later half, is characterized by widespread nor' westers[5] in and around Bengal persisting for days together and thus giving rise to the impression of an early arrival of the monsoon. As a matter of fact, the phenomenon is known in India as the *Chota Barsat* or the little monsoon and is regarded as the precursor of the *Bara*

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[4] *American M. W. R.* June 1936 p. 199 Richardson R. W.

* In January, February, and March of some years (*e. g.* 1901 and 1904) the western disturbances appear to have a marked tendency to form into well marked cyclonic circulations near Gujarat and then travel across the country to the north Bay of Bengal.

[5] These are caused in March, April, May and June by the flow of the eastern Himalayan air below the transition layer, the western Himalayan air being ineffective on account of the formation of the transition layer over Northeast India. Vide Sen S. N. *Nature* Jan. 1931, p. 128.

Barsat or the big monsoon. The interval between the two may fluctuate from a few days to a few weeks. The general criterion for the *Chota Barsat* in Northeast India appears to be the presence of a good and continuous supply of the eastern Himalayan air over North Bengal, Bihar, and the United Provinces with the Bay air to the south. In May, the *Chota Barsat* may be caused by any of the following mechanisms :--

(*a*) The passage of a cyclone into the northwest angle of the Bay of Bengal and the neighbourhood. The cyclone may develop in the Bay itself or a cyclone in the Arabian Sea may induce a sympathetic one in the Bay west of Long. 90° E.

(*b*) The travel of a well-marked western disturbance across the country to the Central Provinces or the accentuation of the seasonal heat "low" over that region.

(*c*) A convergence between the western Himalayan air and the southwesterly branch of the equatorial current in and around the Central Provinces. This is rare in May and is not likely to affect the Everest region seriously.

From the point of view of the Everest expeditions the most important mechanism for the *Chota Barsat* is certainly (*a*) above as the others do not cause such long spells of bad weather as to render mountaineering in the Himalayas impossible. The cyclone tracks for May (Fig. 4) may be conveniently classified into three types, *viz.*, the April type and types I and II. Type I is very similar to the normal tracks in April (the cyclones move from approximately southwest to northeast) but is nearer to the east coast of India. Type II, on the other hand, is characterized by "retrograde" motion in the south of the Bay, the rest of the track being merely a copy of type I inland. Both types, moving close to the east coast of India, ensures a good *Chota Barsat*. It may be interesting to note here that type I are tracks of the cyclones, which while in the northwest angle of the Bay of Bengal, may be slow-moving and severe (particularly when the eastern Himalayan air begins to participate in the circulation below the transition layer), a feature to be dreaded by the Everesters. It may be emphasized that these cyclones forming even in the last week of May seldom settle the monsoon either in Bengal or over the Everest. Apparently the sudden lifting of the transition layer over the Gangetic plain associated with the onset of the *Chota Barsat* cannot last long and there is invariably a return to summer conditions over the greater part of Northeast India, however poor or shortlived these may be. So far as the Everesters are concerned the distinction between the *Chota* and *Bara Barsat* may appear to be without difference from the point of view of heavy snowfall if the former is caused by cyclones. Fortunately, however, the two types of cyclones are of rare occurrence. The long-range forecasting of the *Chota Barsat* is difficult in view of the fact that the phenomenon connotes an accident, *viz.*, the formation or entry of disturbances in the "sensitive region"* for the Everest. It is, however, hoped that when the present method of forecasting has been fully developed, that character of the second half of May would follow as a corollary sufficiently early to be of help to the expeditionists.

The Monsoon Precipitation in Northeast India

(*a*) *The mechanism of rainfall*—In view of the classification of the Indian air masses already given, the mechanism of the monsoon precipitation is a very interesting problem. In consideration of the region, the rain is variously ascribed to orography, instability, auto-convection and convergence so far as the monsoon current is concerned. The discontinuity above the transition level should be productive of some rain, but the height of this increases with the growth of the monsoon. Hitherto no proof, as to how far any of these processes is really at work and what percentage of the total monsoon rainfall each may account for, is available. So far as India is concerned, apart from orographic rain, the only other mechanism which may yield a considerable amount of rainfall is the activity of the front between the monsoon and eastern Himalayan current. A similar mechanism is applicable in the case of Northwest India, *viz*., the front between fresh supplies of the western Himalayan air and the monsoon.

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* The region bounded by latitude 16°N Western Himalayas and longitude 80° and 90°E. (Vide "Himalayan Meteorology").

(*b*) *The monsoon front and mechanism of heavy precipitation*—The daily weather charts support the idea that, in the plains of Northeast India at any rate, frontal activity is the principal mechanism of rainfall during the monsoon. Although at the surface, the horizontal temperature gradient on the average is very feeble during the monsoon, there is, even at the ground level, a *monsoon front** and its normal position over the Gangetic plain has the support of observations of waterspouts extending over a hundred years.[6] As regards its activity, it should be noted that daily forecasts of precipitation are always to be made with a full appreciation of the fact that the supply of the eastern Himalayan air is usually susceptible to large and rather periodic fluctuations. In order to illustrate the frontal mechanism of the monsoon rainfall on a large scale and well within the Indian area, the weather chart for the 6th September 1936 has been chosen. The idealized chart (with the actual winds at 0.5 Km. above M. S. L. determined from pilot balloon flights and observations at stations at about 0.5 Km. above M. S. L.) is reproduced in Fig. 5 which is self-explanatory. The family of whirls on the monsoon front along with the rainfalls at the various stations (one inch and above) during the following 24 hours, are shown in the diagram. This was the commencement of a spell of heavy rainfall and the regions likely to be affected are clearly indicated from the positions of the westward travelling whirls in the 0. 5 Km. chart from the 6th September 1936 onwards. On the surface, both the dry and wet bulb temperatures fell progressively along the paths of the eastern Himalayan air. The clustering of rainfall of one inch and above to the south of the line of discontinuity is noteworthy. For the various heights of the eastern Himalayas the mechanism of heavy snowfall may be somewhat like the one depicted in Fig. 5.

The Strength of the Monsoon Winds

The subject is complicated and deserves a much more detailed elucidation than is possible in the present article. Only a few interesting points may be noted here. The strengthening of winds in the south of the Bay of Bengal is usually associated with rain and no convergence is noticed in this region. This peculiarity is suggestive of an interaction of the southern winter and the northern summer in the bottom layers of the atmosphere. The strengthening of the monsoon over the north and centre of the Bay of Bengal occurs when a tongue of the continental air advances towards the sea and the same feature is noticed over regions where the two branches of the monsoon converge.

The Monsoon and the Everest

The daily weather reports supplied to the mountaineers since 1930, more or less, demonstrate that the modern idea of air masses and frontal activities is also applicable in the case of important weather phenomena up to such great heights as 30, 000 feet above the mean sea-level. This is the outstanding meteorological result of the various Himalayan expeditions led so far. During future expeditions it would be interesting to study the effects of a sudden onset of the *Chota Barsat* on Everest, if there is one, with particular reference to the formation of avalanches.

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* So far as the daily weather charts show, the initial stages of the formation of depressions in the North Bay in July and August, at any rate, are not any better than the southwestern quadrant of the deformation field arising out of the flow of the monsoon winds against the eastern Himalayas. The precipitation is scanty over the whole field until the Himalayan air appears to the north. The feed of this current appears to consist of somewhat colder air (potentially) than the monsoon winds at the same level. As the depression intensifies the Himalayan air gradually descends (or *vice versa*) while flowing westwards and reaches the the ground in the course of a day or two. A progressive fall of both the dry and wet bulb temperatures then commences at the surface and it is about this stage that rainsqualls start round the head of the Bay.

(6) See Fig. 2 Rains of Fishes, *Proc. Asia. Soc. of Bengal*, Vol. XXIX, pp. 111-116, 1933 by Sen S. N.

The Indian Mathematician—Ramanujan

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I HAVE set myself a task in these lectures which is genuinely difficult and which, if I were determined to begin by making every excuse for failure, I might represent as almost impossible. I have to form myself, as I have never really formed before, and to try to help you to form, some sort of reasoned estimate of the most romantic figure in the recent history of mathematics; a man whose career seems too full of paradoxes and contradictions, who defies almost all the cannons by which we are accustomed to judge one another, and about whom all of us will probably agree in one judgment only, that he was in some sense a very great mathematician.

The difficulties in judging Ramanujan are obvious and formidable enough. Ramanujan was an Indian and I suppose that it is always a little difficult for an Englishman and an Indian to understand one another properly. He was, at the best, a half-educated Indian; he had never had the advantages, such as they are, of an orthodox Indian training; he was never able to pass the 'First Arts Examination' of an Indian university. He worked for most of his life, in practically complete ignorance of modern European mathematics, and died when he was a little over 30 and when his mathematical education had in some ways hardly begun. He published abundantly—his published papers make a volume of nearly 300 pages—but he also left a mass of unpublished work which had never been analysed properly until the last few years. This work includes a great deal that is new, but much more that is rediscovery, and often imperfect rediscovery; and it is sometimes still impossible to distinguish between what he must have rediscovered and what he may somehow have learnt. I cannot imagine anybody saying with any confidence, even now, just how great a mathematician he might have been.

These are genuine difficulties, but I think that we shall find some of them less formidable than they look, and the difficulty which is the greatest for me has nothing to do with the obvious paradoxes of Ramanujan's career. The real difficulty for *me* is that Ramanujan was, in a way, my discovery. I did not invent him—like other great men, he invented himself—but I was the first really competent person who had the chance to see some of his work, and I can still remember with satisfaction that I could recognize at once what a treasure I had found. And I suppose that I still know more of Ramanujan than any one else, and am still the first authority on this particular subject. There are other people in England, Professor Watson in particular, and Professor Mordell, who know parts of his work very much better than I do, but neither Watson nor Mordell knew Ramanujan himself as I did. I saw him and talked to him almost every day for several years, and above all I actually collaborated with him. I owe more to him than to any one else in the world with one exception, and my association with him is the one romantic incident in my life. The difficulty for me then is not that I do not know enough about him, but that I know and feel too much and that I simply cannot be impartial.

I rely, for the facts of Ramanujan's life, on Seshu Aiyar and Ramachaundra Rao, whose memoir of Ramanujan is printed, along with my own in his *Collected Papers*. He was born in 1887 in a Brahmin family at Erode near Kumbakonam, a fair-sized town in the Tanjore district of the Presidency of Madras. His father was a clerk in a cloth-merchant's office in Kumbakonam, and all his relatives, though of high caste, were very poor.

He was sent at the age of 7 to the High School of Kumbakonam, and remained there for nine years. His exceptional abilities had begun to show themselves before he was 10, and by the time that he was 12 or 13 he was recognized as a quite abnormal boy. His biographers tell some curious stories of his early years. They say, for examale, that, soon after he had begun the study of trigonometry, he discovered for himself 'Euler's theorems for the sine and cosine' (by which I understand the relations between the circular and exponential functions), and was very disappointed when he found later, apparently from the volume of Loney's *Trigonometry*, that they were known already. Until he was 16 he had never seen a mathematical book of any higher class. Whittaker's *Modern Analysis* had not yet spread so far, and Bromwich's *Infinite Series* did not exist. There can be no doubt that either of these books would have made a tremendous difference to him if they could have come his way. It was a book of a very different kind, Carr's *Synopsis*, which first aroused Ramanujan's full powers.

Carr's book (*Synopsis of elementary results in pure and applied mathematics*, by George Shoobridge Carr, formerly Scholar of Gonville and Caius College, Cambridge, published in two volumes in 1880 and 1886) is almost unprocurable now. There is a copy in the Cambridge University Library, and there happened to be one in the library of the Government College of Kumbakonam, which was borrowed for Ramanujan by a friend. The book is not in any sense a great one, but Ramanujan has made it famous, and there is no doubt that it influenced him profoundly and that his acquaintance with it marked the real starting point of his career. Such book must have had its qualities, and Carr's, if not a book of any high distinction, is no mere third-rate text-book, but a book written with some real scholarship and enthusiasm, and with a style and individuality of its own. Carr himself, who was a private coach in London, came to Cambridge as an undergraduate when he was nearly 40, was 12th Senior Optime in the Tripos of 1880 (the same year in which he published the first volume of his book), and is now completely forgotten, even in his own college, except in so far as Ramanujan has kept his name alive, must have been in some ways rather a remarkable man.

I suppose that the book is substantially a summary of Carr's coaching notes. If you were a pupil of Carr, you worked through the appropriate sections of the *Synopsis*. It covers roughly the subjects of Schedule A (as these subjects were understood in Cambridge in 1880) and is effectively the 'synopsis' it professes to be. It contains the enunciations of 6165 theorems, systematically and quite scientifically arranged, with proofs which are often little more than cross-references and are decidedly the least interesting part of the book. All this is exaggerated in Ramanujan's famous note-books (which contain practically no proofs at all), and any student of the note-books can see that Ramanujan's ideal of presentation had been copied from Carr's.

Carr has sections on the obvious subjects, algebra, trigonometry, calculus and analytical geometry, but some sections are developed disproportionally, and particularly the formal side of the integral calculus. This seems to have been Carr's pet subject, and the treatment of it is very full and in its way definitely good. There is no theory of functions; and I very much doubt whether Ramanujan, to the end of his life, ever understood at all clearly what an analytical function is. What is more surprising, in view of Carr's own tastes and Ramanujan's later work, is that there are no elliptic functions. However Ramanujan may have acquired his very peculiar knowledge of this theory, it was not from Carr. On the whole, considered as an inspiration for a boy of such abnormal gifts, Carr was not too bad, and Ramanujan responded amazingly.

> "Through the new world thus opened to him, Ramanujan went ranging with delight. It was this book which awakened his genius. He set himself to establish the formulae given therein. As he was without the aid of other books, each solution was a piece of research so

> far as he was concerned..Ramanujan used to say that the goddess of Namakkal inspired him with the formulae in dreams. It is a remarkable fact that frequently, on rising from bed, he would note down results and rapidly verify them, though he was not always able to supply a rigorous proof...."

I have quoted the last sentences deliberately, not because I attach any importance to them—I am no more interested in the goddess of Namakkal than you are—but because we are now approaching the difficult and tragic part of Ramanujan's career, and we must try to understand what we can of his psychology and of the atmosphere surrounding him in his early years.

I am sure that Ramanujan was no mystic and that religion, except in a strictly material sense, played no important part in his life. He was an orthodox high-caste Hindu, and always adhered (indeed with a severity most unusual in Indians resident in England) to all the observances of his caste. He had promised his parents to do so, and he kept his promises to the letter. He was a vegetarian in the strictest sense, and all the time he was in Cambridge he cooked all his food himself, and never cooked it without first changing into pyjamas.

Now the two memoirs of Ramanujan printed in the *Papers* (and both written by men who, in their different ways, knew him very well) contradict one another flatly about his religion. Seshu Aiyar and Ramachaundra Rao say

> "Ramanujan had definite religious views. He had a special veneration for the Namakkal goddess....He believed in the existence of a Supreme Being and in the attainment of Godhead by men....He had settled convictions about the problem of life and after....",

> "....his religion was a matter of observance and not of intellectual conviction, and I remember well his telling me (much to my surprise) that all religions seemed to him more or less equally true...."

Which of us is right? For my part I have no doubt at all; I am quite certain that I am.

Classical scholars have, I belive, a general principle, *difficilior lectio potior*—the more difficult reading is to be preferred—in textual criticism. If the Archbishop of Canterbury tells one man that he believes in God, and another that he does not, then it is probably the second assertion which is true, since otherwise it is very difficult to understand why he should have made it, while there are many excellent reasons for his making the first whether it be true or false. Similarly, if a strict Brahmin like Ramanujan told me, as he certainly did, that he had no definite beliefs, it is 100 to 1 that he meant what he said.

This question of Ramanujan's religion is not itself important, but it is not altogether irrelevant, because there is one thing which I am really anxious to insist upon as strongly as I can. There is quite enough about Ramanujan that is difficult to understand, and we have no need to go out of our way to manufacture mystery. For myself, I liked and admired him enough to wish to be a rationalist about him; and I want to make it quite clear to you that Ramanujan, when he was living in Cambridge in good health and comfortable surroundings, was, in spite of his oddities, as reasonable, as sane, and in his way as shrewd a person as any one here. The last thing which I want you to do is to throw up your hands and exclaim: 'Here is something unintelligible, some mysterious throwback from the immemorial wisdom of the East'; I do not believe in the immemorial wisdom of the East, and the picture I want to present to you is that of a man who had his peculiarities like other distinguished men, but a man in whose society one could take pleasure, with whom one could take tea and discuss politics or mathematics; the picture, in short, not of a wonder from the East, or an inspired idiot, or a psychological freak, but of a rational human being who happened to be a great mathematician. Until he was about 17, all went well with Ramanujan.

> "In December 1903 he passed the Matriculation Examination of the University of Madras, and in the January of the succeeding year he joined the Junior First in Arts class of the Government College, Kumbakonam, and won the Subrahmanyam scholarship, which is generally awarded for proficiency in English and Mathematics."

But after this there came a series of tragic checks.

> "By this time, he was so absorbed in the study of mathematics that in all lecture hours—whether devoted to English,

> History, or Physiology—he used to engage himself in some mathematical investigation, unmindful of what was happening in the class. This excessive devotion to mathematics and his consequent neglect of the other subjects resulted in his failure to secure promotion to the senior class and in the consequent discontinuance of the scholarship. Partly owing to disappointment and partly owing to the influence of a friend, he ran away northward into the Telugu country, but returned to Kumbakonam after some wandering and rejoined the college. As owing to his absence he failed to make sufficient attendances to obtain his term certificate in 1905, he entered Pachaiyappa's College, Madras, in 1906, but falling ill returned to Kumbakonam. He appeared as a private student for the F. A. examination of December 1907 and failed."

Ramanujan does not seem to have any definite occupation, except mathematics, until 1912. In 1909 he married, and it became necessary for him to have some regular employment, but he had great difficulty in finding any because of his unfortunate college career. About 1910 he began to find more influential Indian friends, Ramaswami Aiyar and his two biographers, but all their efforts to find a tolerable position for him failed, and in 1912 he became a clerk in the office of the Port Trust of Madras. He was then nearly 25. The years between 18 and 25 are the critical years in a mathematician's career, and the damage had been done. Ramanujan's genius never had again its chance of full development.

There is not much to say about the rest of Ramanujan's life. His first substantial powers began to be understood. Sir Francis Spring and Sir Gilbert Walker obtained a special scholarship for him, £ 60 a year, sufficient for a married Indian to live in tolerable comfort. At the beginning of 1913 he wrote to me, and Professor Neville and I, after many difficulties, got him to England in 1914. Here he had three years of uninterrupted activity, the results of which you can read in his *Papers*. He fell ill in the summer of 1917, and never really recovered, though he continued to work, rather spasmodically, but with no real sign of degeneration, until his death in 1920. His last mathematical letter on 'Mock-Theta functions', the subject of Professor Watson's presidential address to the London Mathematical Society last year, was written about two months before he died.

The real tragedy about Ramanujan was not his early death. It is of course a disaster that any great man should die young, but a mathematician is often comparatively old at 30, and his death may be less of a catastrophe than it seems. Abel died at 26 and, although he would no doubt have added a great deal more to mathematics, he could hardly have become a greater man. The tragedy of Ramanujan was not that he died young but that, during his five unfortunate years, his genius was misdirected, sidetracked, and to a certain extent distorted.

I have been looking again through what I wrote about Ramanujan 16 years ago, and, although I know a good deal better now than I did then, and can think about him more dispassionately, I do not find a great deal which I should particularly want to alter. But there is just one sentence which now seems to me quite indefensible. I wrote :

> "Opinions may differ about the importance of Ramanujan's work, the kind of standard by which it should be judged, and the influence which it is likely to have on the mathematics of the future. It has not the simplicity and the inevitableness of the very greatest work ; it would be greater if it were less strange. One gift it shows which no one can deny, profound and invincible originality. He would probably have been a greater mathematician if he could have been caught and tamed a little in his youth ; he would have discovered more that was new, and that, no doubt, of greater importance. On the other hand he would have been less of a Ramanujan, and more of a European professor, and the loss might have been greater than the gain."

I stand by that except for the last sentence, which is quite ridiculous sentimentalism. There was no gain at all when the College at Kumbakonam rejected the one great man they had ever possessed, and the loss was irreparable ; it is the worst instance that I know of the damage that can be done by an inefficient and inelastic educational system. So little was wanted, 60 a year for five years, occasional contact with almost any one who had real knowledge and a little imagination, for the world to have gained another of its greatest mathematicians.*

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* From a lecture given at the Harvard Tercentenary Conference published with the kind permission of the Director of the Conference.

Accidents in Indian Coal Mines

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Introduction

In introducing this article, I would like to make it clear at the outset that the main object, which has prompted me to place it before my readers, has been to explore the possibilities of reducing the number of accidents in coal mines by focussing the attention of all concerned on this important subject without in any way criticizing the work of the various managers, mining engineers and others, all of whom have contributed so much towards the safe and efficient working of the Indian coal mines.

In the year 1921 Mr R. R. Simpson, C. I. E., the Chief Inspector of Mines in India, wrote a paper on this subject.[1] Evidently his close touch with all the mines in India enabled him to produce such a paper. But since he wrote on the subject, coal mining in India has advanced considerably and consequently many new complications have arisen. Besides, an important change in the angle of vision of the owner and managers of mines in respect of accidents, has been effected by the enactment of the Workmen's Compensation Act (1923). Further, many fresh and energetic managers have come out in the course of these *ten years*, who *now* hold positions of trust in the various mines.

No deformity or death caused by a mining accident to an employee can be made good by any amount of compensation. It is, therefore, a moral *obligation on the part of the employers to make* sure, before employing any worker in any place or job, that the latter can be so employed without any risk to life or limb. If this principle is observed, it is quite certain that the number of accidents will be reduced considerably.

All important cases of accident have been dealt with by the Chief Inspectors of Mines in their annual reports. I will not, therefore, dwell upon them in detail but would invite your attention to the remarks made by the Chief Inspectors from year to year.

In my opinion accidents may broadly be classed under two heads :

(1) Those which cannot be foreseen and consequently, cannot be guarded against.

(2) Those which are caused by breach of regulations, rules and bye-laws, carelessness, sometimes by faulty materials, etc., and are therefore preventible.

In the present article only such cases as may be classed under (2) have been discussed.

For the purpose of this paper, the accidents which occurred in the coal mines under the Indian Mines Act IV of 1923, during 1925-29 are chiefly taken into account.

Table 1 shows the number of persons killed and seriously injured in mining accidents during the above period.

Explosions and Ignitions of Firedamp

Thanks to the amount of care taken by the managers, these accidents are not many in number. But it cannot be taken lightly as even a single occurrence might claim a heavy toll of life.

Many mine owners and managers, who work second-grade coal, are under the impression that owing to the stony nature of the seams their mines are not exposed to the risk of coal dust explosions.

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[1] *Transactions of the Min. & Geo. Inst. of India* Vol. XVI pt. I.

The Coal Dust Committee has, however, proved by actual experiment that under favourable conditions, coal dust from all grades of coal is explosive. It is therefore incumbent on all managers to see that dry and fine coal dust does not accumulate in their mines.

It is known to mining men that firedamp can be ignited by (*a*) naked light, (*b*) faulty safety lamp, or (*c*) shot-firing. I shall discuss these cases in detail.

(*a*) *Naked Light :* Use of open light is not permitted by the Indian Coal Mines (I. C. M.) regulations in the workings of mines where gas is likely to be found or has been found within 12 months previously. In spite of this, accidents due to ignition of firedamp occur from time to time. Some of these accidents occurred in mines or parts of mines where no gas had previously been found.

Managers, who have worked for a long time in non-gassy seams are, on taking over charge of new collieries, liable to overlook the fact that although the seams they are going to work may not be pro-

TABLE No. I.

Showing the number of persons seriously injured and killed in coal mines by accidents during 1925—29.

YEAR.	Explosion and ignition of firedamp.	Falls of roof.	Falls of sides.	INSHAFTS						Suffocation by gases.	By Explosives.	Irruption of water.	Haulage.	By underground machinery.	Sundries underground.	Surface machinery.	Boilers or pipes bursting.	On surface railways and tramways belonging to the mine.	By electricity.	Miscellaneous on the surfaces.	Total fatal accidents in the year.	Total serious accidents in the year.	Fatal accidents per 1,000 persons employed under ground and on the surface.	Fatal accidents per million tones of coal raised.
				Overwinding.	Ropes and chains breaking.	Whilst ascending or descending by machinery.	Falling down shaft.	Things falling down shaft.	Miscellaneous.															
1925	1	61	62	—	—	18	9	1	5	3	19	—	15	3	12	2	—	5	2	15	233	479	·92	9·31
1926	5	53	69	3	2	2	1	4	5	2	17	—	26	—	12	2		11	1	12	227	597	·87	8·51
1927	1	63	59	1	—	2	4	2	1	9	27	—	24	3	20	5	—	16	2	8	247	680	·92	8·57
1928	3	84	58	—	—	1	7	4	4	1	17	7	27	2	12	2	—	5	2	21	259	654	·97	10·13
1929	8	99	54	—	—	—	8	2	3	2	9	—	31	3	18	3	—	12	2	12	266	651	·99	8·70

ducing gas for the time being yet they may prove gassy at a particular section of the mine. A consultation with the Inspectors of Mines will enlighten them on this point when they would be able to prepare themselves well in advance to meet the case.

Ignitions of gas are known to have occurred in narrow and long galleries, especially in those driven too far in advance of ventilating current in the rise side or in the vicinity of faults and dykes. It is therefore possible to guard against an ignition :-

(*i*) By arranging for an adequate amount of air to flow constantly along the faces. In order to emphasize the importance of the adequacy of ventilation, the following cases may be cited. By an accidental damage to a safety lamp in a rise gallery an ignition of firedamp occurred. In another case, firedamp accumulated in a gallery in which a miner was at work. His pick caused sparks to be produced which were sufficient to ignite the gas. An accident occurred to a miner, who unaware of the fact that gas was escaping through a stopping, had brought an open light near the same causing an ignition. A miner, while working in the stone above a coal seam, produced sparks by his pick and thereby caused an ignition of the gas which had accumulated there.

(*ii*) By avoiding the driving of such narrow and long headings, especially on the rise.

(*iii*) By the use of safety lamps in all connecting headings and in galleries which are being driven in close proximity to faults and dykes no matter whether gas has been detected previously or not. I am not suggesting the provision of a few safety lamps in every colliery only for the aforesaid purpose but it may be pointed out that under the regulations it is necessary that, during the course of the statutory daily inspection of the mines, tests have to be made to detect unexpected accumulation of gas and these cannot, strictly speaking, be made properly without the aid of safety lamps.

In some mines the use of safety lamps in some parts and open lights in others is still prevalent. Accidents are known to have occurred by ignitions of firedamp by open lights which miners inadvertently brought into safety lamp sections. This fact should be sufficient to discourage the use of mixed lights in a mine. It is therefore desirable that safety lamps should be more liberally used than is necessary to meet the minimum requirements of the Indian Coal Mines Regulations. The amount of safety thus ensured far outweighs the small extra cost and discomfort in its use.

Use of open light in the fan room and fan exit has caused accident. Only locked safety lamps should be provided for use in these places.

(*b*) *Faulty safety lamps*: The I. C. M. Regulations prohibit the use of such lamps in a mine but they are occasionally to be found in some mines.

The persons in charge of lamp rooms sometimes negligently issue defective safety lamps to mine workers, little knowing the amount of risk which is thereby incurred. I am of opinion that in order to make them realize the danger involved in the use of defective safety lamps in a gassy mine they should, before being entrusted with safety lamps, be taken into a gassy face where a thorough demonstration of the presence of gas can be given and the danger of igniting the gas be explained. I believe that once they actually realize the danger they would take due care in cleaning, fitting and thoroughly examining the lamps before the workers are sent down the mine.

A sufficient stock of safety lamps is not maintained in some mines. Thus whenever there is a rush of miners defective lamps may be issued, sometimes with a cheap type of glass (not of approved type) and single guazes which are not permitted by the Regulations.

It is a common complaint that miners tamper with the lamps in the mine. Indeed, there are offenders in some cases, especially when no gas is found for some months together. New recruits are mainly guilty of this offence and this is no doubt due to absolute ignorance of the danger. It is therefore essential that before a safety lamp is handed over to a miner he should be explained the dangers of tampering with the lamp. The miner should then be placed in charge of an underground official who should demonstrate to him the use of the lamp and the method of testing for gas. It may be argued that it is too much to expect of a miner to understand all these things; but it should be remembered that this is a question of safety not only to the miner himself but also to others working in the mine. It is therefore imperative to the management to see that every man thoroughly understands the use of a safety lamp before he is entrusted with one in the workings of a mine.

Why does a miner tamper with a safety lamp? No *biri* or smoking apparatus is allowed to be taken underground; he does not therefore want an open light for enjoying his smoke. Is it not a fact that he attempts and sometimes actually does unlock a safety lamp in order to relight an extinguished one? If this be the case, the remedy is simple enough. Where no relighting stations have been provided, each gang of work-persons may be supplied with, say, 10 to 15% more lamps than what is actually meant for use; besides, a few spare lamps may be kept in readiness to be exchanged with extinguished ones in the in-bye districts which are far from the mine entrance.

Very few safety-lamp mines are provided with underground lighting stations. Thus miners may have to walk a considerable distance in the darkness in order to obtain another light or to have his lamp relit from the surface. Such a practice, if not stopped by some of the means suggested above, might result in an accident.

The number on the body of a safety lamp is sometimes found different from that shown on the oil-container. Unless the same number is maintained on both the parts its object is frustrated.

Detection of cases of tampering is possible only when a proper rivetting machine is used in locking the lamps; the ordinary lead plugs may be opened and refitted by the miners without much difficulty. Magnetic locks are much more reliable.

Shot Firing: Accidents are known to have occurred through the ignition of firedamp by a spark propagated by blasting. As a precautionary measure, only permitted explosives are recommended and used in gassy, dry, and dusty mines. A further precaution enjoins that the galleries should be made dust-free and wet before commencing the blasting operations. Where the whole operation is left in the hands of shot-firers there is room for doubt if this important precaution is always taken.

Unless the proper quantity of charge is used and the position of the holes correctly selected, there is a risk of a blown-out shot which in an ill-ventilated gassy face may cause an explosion. But it is regrettable that an important work of the nature described above is almost invariably left to the discretion of a common miner or of a shot-firer hardly better than a miner. Under normal conditions these shot-firers do fairly well; but in gassy, dry, and dusty mines more intelligent persons should decide the question of placing and charging of shot holes under varying conditions. Before firing a shot in a gassy mine an inspection must be made for gas by a person qualified in gas testing.

A large percentage of accidents is due to explosives and the safety of lives and properties depend on the judgment of shot-firers to a great extent. There are a number of managers who always want the Mines Department to take the initiative. But why wait till the Mines Department enforces a standard for this class of workers? Is it not possible to have a standard for your particular mine and to satisfy yourself that a candidate is up to it before you so liberally issue an authorization? In fact regulation 25 of I. C. M. R. contemplates this.

Fall of Roof

This class of mining accident accounts for the highest percentage of mortality every year even in India where the roofs generally are more dependable and sound than in European coal mines.

There are some coal mines in India that need no timbering whatsoever during the whole working, while during the removal of coal pillars, props set at 3′ to 6′ centres meet the requirements. A little steel support has been given in some sections of a few mines more for the sake of permanence than to meet the actual roof weight. The mines being comparatively shallow, exceptionally bad ground, heaving, thrust, etc., are seldom met with.

Why do then such a large number of accidents due to fall of roof occur every year ? Perhaps one or other of the following is a contributing cause :-

(*a*) *The daily examination* is a cursory one due to over-confidence in the strength of the roof. This is especially the case where one sirdar or overman is required to supervise too big an area. There can be no denial of the fact that in this particular respect the consideration of safety is sacrificed by some owners, and consequently by their managers too, for the sake of economy ; this is false economy, for in the event of a major accident, payment of heavy compensations has to be made. In several mines the number of the supervising staff is determined not by the size and the complication of the particular mine, but by the minimum figure that could be made acceptable to the Mines Department.

(*b*) There are mines where a number of qualified sirdars have been appointed but they are given so many other duties that they spend most, if not all, of their time in attending to them and find little time for the proper inspection of the mine under Reg. 70. A common duty of the sirdars is to allot tubs to the miners and to see that they are properly loaded. This means that under the orders of the manager the sirdars would spend a major portion of their time on the loading lines. Again, practically speaking, the safety of the miners in their working places depends on the careful examinations made by the sirdar at frequent intervals. But the sirdar or overman of a non-gassy mine is generally provided with a "Mug-lamp" or at the most, a hand-lantern. The mug-lamp emits so much smoke when the wick is properly drawn out that the examination of a roof of even medium height becomes almost impossible. With a hand-lantern only the floor and the sides up to a certain height can be seen ; and the examination of the roof with such light is merely a guesswork. Unless a strong light is provided, the thorough inspection as required under Reg. 70 cannot be made. In thick seam workings, even a carbide lamp cannot be considered good enough ; so, for the proper examination of such roof and sides, approved electric torches should also be provided. The additional cost involved would be more than repaid by the reduced number of accidents and consequential reduction in payment of compensation.

Then again, for a thorough examination of thick seam workings, a long pole must be carried all over the workings. In the collieries where the overman (who is often recruited from respectable communities and hence considers it beneath his dignity to do the work of a common labourer) is not provided with an *attendant* to carry the long testing pole for him, he is likely to be satisfied with making a visual examination of the roof and the sides instead of using the pole.

No proper means for satisfactory inspection of the travelling roads has been provided in several collieries working thick seams.

Where the sirdar or overman himself is required to dress down the weak roof and sides, the work is apt to be constantly put off until it becomes too unsafe or an accident actually occurs. Unless the mine has got an exceptionally strong roof, the manager would be well advised in keeping at least one *roof-dresser* in each mine : this man could easily be employed in some other work underground at times when he would be free from his ordinary duty.

If, as required by the regulations, the miners were trained to test their working places at frequent intervals, a large number of accidents could be avoided. This is not a difficult proposition ; I have seen it done by all the miners in at least one mine.

(*c*) *Pillar Robbing* is a fruitful source of accident. Pillar-robbing to any considerable extent is practised only in those mines where the management either connives at it or is slack in supervision. Pillar-robbing can be stopped by a closer supervision, liberal lime-marking of pillars preferably with wide brushes, erection and maintenance of substantial fencing and the prosecution of offenders. Mere stoppage of payment for the robbed coal is not a punishment, rather, it tends to increase the crime. Perhaps the overmanning of the working galleries induces the miners to rob pillars. It is far better to send surplus miners away if there is a shortage of working places. If the miners are left to themselves to find their own working places some at least would invariably attempt to obtain coal illegally.

In mines where the payment for gallery working is based on the footage and not per tub of coal loaded, there is no temptation for the miners to widen the galleries or to rob the pillars. Wherever possible, this system should be introduced in "whole work."

There have been cases where, according to the management, the miners deliberately crossed the fences to rob pillars but the miners themselves denied the charge and held that they had met with the accident in their bonafide working places. Such a state of things is entirely due to the erection of flimsy fences. When a place is considered to be dangerous, the danger should be removed at once, if possible, otherwise a substantial fencing should be put up not only to prevent entrance but to prove beyond dispute, that there was fence in case anyone deliberately enters.

(*d*) *Failure to examine the roof and the sides after blasting* has led to many accidents. It has been found that loaders return to the gallery soon after blasting and before the shot-firer or some other competent person has made an inspection, commence loading the blasted coal when some loose pieces fall and hit them causing an accident. In order to avoid this sort of accident it is important to see that the shot-firer does not leave the section of the mine immediately after blasting. He must wait till the smoke clears and then make careful examination for loose pieces of coal or stone in roof and sides before proceeding to attend to work elsewhere. If necessary a few additional shot-firers may be appointed in big mines so as to bring their circles of operation within reasonable limits.

(*e*) It has been noticed in the workings of some mines that where a pronounced slip has appeared in the middle of a gallery it has been exposed continuously as long as it followed the bearing on which the gallery was being driven. Unless it was meant for haulage, drainage or some other important purpose, the course of the gallery could be slightly altered to cause the slip to rest on solid pillars. This simple precaution would do away with the future necessity of supporting the gallery, failure of which leads to an accident. It has already been recommended by the Chief Inspector of Mines that whenever galleries are driven in close proximity to faults or dykes, every precaution should be taken to keep the roof secure. Safety timbers should always be set whether it appears necessary or not. Wherever there is a suspicion that the roof is or will become tender, timbering should be made liberally. The cross-joints are sources of danger and should be dealt with in a similar manner.

(*f*) It has been found that props and chocks are not always set properly. In propping, sometimes too small a lid is used where a bigger one would have served better. Sometimes a wedge is set in the wrong direction; some props are too thin or crooked to render effective service. The *Bari* or timber mistry (often a common labourer who knows only how to cut rollas into pieces and to set them somehow) is usually the person to use his discretion in selecting and setting props. In a few mines only, is he guided by the supervising staff in the matter. Props are seen to have been set on loose material in some mines instead of on the solid ground, such a prop can give no support to the roof. In setting bars too, the right sort of timber is not always used. In some mines there are bars which hardly touch the roof, owing, first, to their crookedness and secondly to the absence of any lagging to hold them tight against the roof. Owing to holes of insufficient depth in the sides some bars, when set, simply crush the side coal as soon as the weight which they are meant to bear comes on. Thus, such bars serve to give only a false sense of security. This remark also applies to many stone packs or chocks, which once built tight against the roof, sink considerably deep but remain unnoticed. In certain mines it is found that the floor coal has been removed in such a way as not to leave even a foot of coal for the support of props erected to withstand the roof weight. Even the simple precaution of erecting a temporary support before the removal of an old timber is not always taken. If the supervising staff were strict in the matter, the defects regarding setting of timbers would disappear soon.

If, while going their rounds, the managers and their assistants find insecure places some of them finish their duties by ordering the timberman to erect timber. If the timberman is an experienced hand, he does the job fairly well, but generally the work is done perfunctorily and thus its purpose is defeated. Mere orders given for the timbering or the dressing of a roof are not sufficient. The indifference of the supervising staff in this respect has led to many accidents.

Failure to take due precaution has caused accidents to many timbermen while engaged in setting supports. It is therefore important that in bad ground the work of erecting support should be carried on under the supervision of one of the mine officials. This is done in well-organized mines but unfortunately their number is small.

(*g*) In dressing roof or side coal, the miners make their own arrangements where *no platforms are provided by the management*. These arrangements are very unsatisfactory and do not afford the miners security in case they have to dislodge larger pieces of coal than they expected. There have been several cases of accident from this source. In every mine where the roof cannot be reached easily and where the dressing of roof and side coal or stone has to be carried on for some time, suitable platforms should be provided for and kept in readiness for use. This should be done particularly when such an operation has to be carried on in depillaring sections where the conditions of the roof and sides may alter at any moment. In depillaring sections the unsupported roof between the last row of props and the face is occasionally left unnecessarily wide. This is always the case in mines where there are not a sufficient number of timbermen.

The practice of *holding the roof on props over a fairly large area* in depillaring sections has led to accidents. "Roof coal should be taken down in all loading levels to a distance from the goaf never less than the length of two pillars, and the rails should be removed from the loading level before the timber is withdrawn from a goaf." Safety prop drawers are not used in many mines in which pillars are extracted.

The extraction of thick seam pillars requires specially trained timbermen to reduce the risk in this dangerous operation to a minimum. It is therefore important that only those timbermen who have been trained in thick seam extraction work should be employed. Sometimes undue reliance is placed on the soundness of the roof and the dressing of pillars is kept going on until an extensive fall of the roof occurs.

A sudden and extensive fall of roof in the goaded area causes an "air blast" and many persons have lost their lives on this account. The only way to minimize this danger, as recommended by the Mines Department, is to encourage the break of the main roof on smallar areas along with the "broken work."

The dressing of the soft shale or roof stone is sometimes held in abeyance. At times accidents occur, due to the fall of a piece. The plea for not dressing the stone and shale is that it is difficult to dress them down until they are sufficiently weathered. Under such circumstances, it is advisable to erect temporary supports for such roofs.

In some workings the exhaust steam from underground engines and pumps is allowed to escape into the workings and there is no arrangement to take it out of the mine. This steam has a detrimental effect on a certain class of roof.

(*h*) Every year, a number of persons are killed while attempting to *remove coal from fenced areas*, especially along the edges of goaves. In some mines a single strand of wire is attached to two pieces of timbers or sleepers which are kept leaning against the pillars on either side of the road which is supposed to be kept fenced. This sort of fencing, if at all meant to meet the requirements of the I.C.M Regs., does not serve any useful purpose. The miner is tempted to enter the prohibited area quickly by removing the timber or sleeper from one side. If he is caught, he says that the fence dropped and that he has not crossed any fence. In order to minimize accidents from this source, substantial and double rows of barbed wire fences should be erected and maintained. It might be stated here that in these days the erection of fences has frequently got the final say in settling the claim for compensation following an accident in or about a goaf or prohibited area.

If arrangements are made to sprinkle lime or some suitably coloured water over the fallen coal in the goaved area by means of a spray (hand) pump, the miners would be discouraged (fearing easy detection) from entering the goaved area for the easy coal.

In some cases, the haulage posts of coal-cutters were not set in normal ground with the result that as soon as the post was taut a portion of the local roof came down and caused an accident.

Fall of Sides

Accidents under this head come next in importance.

In some mines thick seams of coal are worked in steps. These give the supervising staff an opportunity of making a close examination of the sides and the roof and thereby ensure greater security. This method of work should therefore be introduced wherever practicable.

If the sides are not left overhanging many accidents can be averted. In a large number of mines the miners are allowed to undercut the side to a much greater extent than what they are capable of dressing down in the course of their shifts; the result is that the sides stand overhanging until the supervising staff happen to notice it and get some miner to dress it down. If the miners are allowed to undercut only so much of the face as they are capable of working in a particular shift, no overhang would form.

"Slips" in the coal itself are responsible for a number of accidents. Some are well pronounced; others, though not clearly pronounced, may be detected if carefully examined by a strong light, such as an electric torch. In workings full of slips and cross-joints, the use of a torch by the supervising staff should be made compulsory. Hidden slips may not be guarded against, but those detected should promptly be made secure. Delay in doing this has sometimes caused accidents. Workings in the proximity of dykes and faults should be kept under proper observation.

In certain seams, the sides peel off the middle of the pillars when the coal above overhangs in a dangerous manner. In well-managed mines rows of substantial wire fencing are erected in the middle of the travelling roads and sufficiently far from the sides of pillars to prevent persons from going near the sides either to lean against them or to rob them. This excellent practice should be followed in all mines working under similar conditions and also where pillar-robbing is a regular occurrence.

In fairly soft seams the undercut portions of the galleries should be temporarily supported by spragging. This safe method is not always adopted.

The sides are sometimes damaged by blasting and should be carefully examined by a competent person, who should be specially appointed in writing for the purpose, before the loaders are allowed to enter the place. The sides of pillars become shattered and fissured to a much greater extent by blasting than by hand-picking. The blasting of soft coal to obtain a large output can be justified only when special care is taken to prevent falls.

Falls occur mostly in the pillar-cutting sections, specially when the seam is fairly thick. With the weighting in the neighbouring goaf, the pillars are more or less crushed and unless frequent inspections are made the dangerous condition of the pillars cannot be detected in good time. The side coal then bursts, killing persons in the immediate neighbourhood. Experienced pillar-cutting sirdars frequently stop work for a while and ascertain by listening whether the goaf is "talking." If the sides are tested at regular intervals by the supervising staff the miners working there will naturally be on the alert and may therefore escape from unexpected falls. It has often been found that callous persons failed to take notice of the short and sudden warnings given by the roof and sides in the depillaring sections and thus met with accidents. In my opinion no females, and only the smart male workers, should be employed in the immediate vicinity of the pillars under extraction.

Where the sides are loose on travelling or haulage roads, the repair or support should be more substantial than when it is in mines. There have been cases where the poor timbering gave way earlier than expected and led to an accident.

In open workings too, many accidents occur by the fall of sides. A majority of these cases is due to the avoidance of "dead-work" to an undue extent. If the overburden is stripped back in advance of the working face, accidents of this type will hardly ever occur. This is very well known to all concerned, but unfortunately there are at least some who appear to have little or no regard for human life and thus do not hesitate to keep the workings in a dangerous state until detected by officers of the Mines Department. There have been cases too where insufficiency of the slope of sides was due to ignorance of the supervising staff about the real nature of the overburden to be dealt with. It has always been recommended that in all loose ground, the sides should be sloped back at an angle of about 45° or, if stepped back, the steps should not be more than five feet high and not less than five feet in width. If these suggestions were followed many accidents would be avoided.

The undercutting of sides is done by miners where the supervision is not strict and where the overburden is left standing as long as possible for the sake of economy at the sacrifice of safety. The sides should always be worked from the top downwards to ensure the maximum amount of safety.

Sometimes persons are employed to work both on the top as well as the lower parts and the bottom of the slope. Thus, if a piece is rolled down the slope, the men working below are injured. If the supervising staff is not neglectful, this will not happen.

In many quarries, loose pieces of stone, etc., are found lying on the edge while miners are employed immediately below. In order to avoid accidents from these stones falling on the workers, they should be removed at least five feet away from the edge.

Possible Accidents in Shafts

(a) *Overwinding*: Fortunately there have not been many accidents of this class during the period under review. The reason for this rarity is that many companies working deep shafts have provided overwinding prevention devices for the winding engines. Where the contrivance fails the failure is generally due to the neglect in bringing the contrivance into operation for a long time. It is essential that such contrivance should be tried from time to time and at the same time it is necessary to train the winding engine driver in handling the engine in case of an overwind. The simpler the overwinding preventive device provided, the more dependable it will be as there are few complicated parts likely to go out of order. It has been found that overwinding has been caused by an inexperienced or unauthorized person driving the winding engine or even by an experienced engine-driver when overworked. By arranging for suitable relieving hands the management can prevent such an occurrence. No person should be given charge of a winding engine merely on his presenting to the manager the counterpart of an authorization issued by a manager of some other colliery. The applicant should be thoroughly examined and appointed only when he proves to be a competent person. Only the best hands should be entrusted with the post of an engine-driver as there are cases on record to show that even experienced enginemen have lost control of the engine and thus caused accidents. As many winders are not fitted with the overwinding preventive device it is advisable, although the Regs. do not demand it, that shafts of less than 150 feet in depth too should be provided with detaching hooks. Occasionally it is found that the brake of an winding engine is working loose or a winding engine has not been provided with an adequate brake. It is desirable that the manager should himself occasionally test the efficiency of the winder brake.

(b) *Ropes and Chains Breaking*: It will appear from the table that this class claims the lowest number of fatalities. Undoubtedly this is due to a careful selection and examination of ropes, chains and all materials used for lowering and raising persons as recommended by Mr Simpson in his paper.

It would be a good practice to have the portion cut off at the time of each recapping thoroughly tested and strength, etc., determined to allow a sufficient factor of safety for future use of the rope. In calculating the factor of safety the sudden jerk owing to a breakdown of the teeth on the pinion wheel of a winding engine should be taken into consideration. The rope should not be overstrained by lifting heavy loads. In wet shaft the rope should be greased more than once a week. Non-spinning ropes for sinking pits have been recommended.

(c) *While ascending and descending by Machinery*: A large number of these accidents were due to absence of cage gates in the past. With the introduction of regulation 58 (k) this class of accident has been considerably reduced and in the year 1929 there was no report of any case. Most of these accidents in recent years have occurred to members of the staff who have not bothered to have the gates fixed.

As a result of allowing the guide ropes to work slack some accidents have occurred by cages and by the cage and the balance weight colliding at the meeting. In deep shafts a little slackness of the guides would cause a considerable oscillation of the cages while in motion. It has been recommended that to meet all conditions four guides should be fitted to each cage and under normal conditions the minimum number of guides per cage should be three. It is essential that all guide ropes should be tensioned properly and kept so in order to prevent swinging. A mishap to the winding engine may cause overwinding and accident to the men in the descending cage. If some device to prevent an overwind is fitted to the engine, the loss of life can be averted.

It has been recommended that a sirdar or some other responsible person should accompany all newcomers when descending the shaft for the first time. It is to be regretted that this recommendation is not carried out in many mines. An accident was caused by an onsetter signalling away the cage before it was ready to ascend. If onsetters are watched for a time by an official of the mine while they are performing their duties, any mistake done by them can be found out and corrected on the spot. This is particularly important when a new onsetter is appointed. In order to enter or leave a bucket at mid-landing, suitable arrangements should be made for holding the bucket to the side. A chain, etc., may be provided to which the bucket may be hitched.

(d) *Falling down the shaft*: Accidents were reported in which persons fell down the shaft through the opening between the edge of the shaft and the trolley while they were entering or leaving the bucket. Such accidents can be avoided by providing stops or clamps across the trolley rails to prevent the trolley being pushed too far. The greater and not only a small portion of the shaft top and mid-insets should be kept covered.

Workers are in the habit of removing fences provided for safety when they are employed to work in or about a place but some of them are careless enough to leave the place unfenced when the work is completed or even when it is left incomplete at the end of the day. Such a practice has led to many accidents and should be stopped by severe punishment.

The banksmen are often found pulling tubs out of cages before the cages are lowered on to the keps. An accident occurred owing to the keps not coming into operation and the cage descending with the tub and the banksman down the shaft a few feet. If the danger is explained to the banksmen they may be persuaded to wait till the cage is seated on the keps. It has been recommended that in order to guard against this danger the keps should be weighted.

Before sending men to work in a shaft, it is important that the supervising staff should be satisfied that a suitable scaffold has been provided and also proper arrangements for suspension have been made. A sudden jerk on the scaffold has been known to have upset it and thrown off the rider.

In some airshafts a ladder is fitted up almost vertically to serve as the second outlet of a working mine. Unless a proper ladderway is provided there is every risk of persons falling down while attempting to climb up hurriedly.

(*e*) *Things falling down the shaft* : When overloaded coal tubs are drawn out of the cage at the top of the shaft, some pieces of coal occasionally fall down the shaft and have caused accidents. In order to prevent accidents of this nature, the opening on the pit top when the cage is seated on the keps and also the clearance between the protective roofing and the cage at the bottom of the shaft, should be reduced to a minimum. The onsetter and the trammers are often seen standing close to the shaft bottom when the cages are in motion. Thus, any piece of coal that may be thrown off the tub on the upgoing cage may hit these persons. It is advisable that they should be instructed to keep sufficiently clear of the pit bottom until the cages are at rest.

A careful and not a casual weekly examination of the shaft would eliminate the danger of the pieces of stone or coal dropping from the top or from part of the way down. Very few pit tops are regularly swept clean of loose pieces of coal and stone.

The sides of some shafts are damaged by blasting too close to them in the course of sinking. In order to guard against this danger, hand-dressing of the fairly deep shafts with picks or lining it throughout has been recommended.

The sides of unwalled shafts which are exposed to changing conditions, due to steam pump, etc., have been recommended for a regular and careful examination. Also, a shaft, which has been waterlogged, should be very carefully examined after it has been dewatered.

In sinking shafts the use of protective helmets of suitable design may be recommended.

(*To be continued*).

CONTROL OF PREVENTABLE DISEASE IN WHEAT IN AUSTRALIA

The control of preventable diseases, such as bunt and flag smut, has received earnest consideration in recent years. The treatment of the seed with copper carbonate as a control for bunt is universally adopted, and excellent control has been effected. Occasionally, when the treatment has been neglected a slight infection occurs.

The control of flag smut in the north-west is an interesting story. In the early years it was thought that flag smut would not be a major trouble, as the summer rains would have the effect of germinating the spores in the soil before seeding time. However, with the continued use of susceptible varieties, such as *Canberra, Aussie, Waratah, and Hard Federation* up till 1931, considerable losses were sustained by this disease.

Flag smut has been controlled by the earlier working of the fallows and the use of resistant varieties. In the earlier part of the period being reviewed the susceptible varieties mentioned were grown extensively, and stock were fed on flag smutted hay made from these crops. This, together with the grazing of flag smut stubble, was responsible for disseminating the spores throughout the farms. With the more general use of resistant varieties, such as Nabawa, Ford and Geeralying, and where tractors are being used, the disease is not responsible for losses in yield.—*The Agriculture Gazette*, April, 1937.

Breeding for Disease Resistance in Agricultural Plants

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It is no exaggeration to say that, since 1901 plant-breeding has been revolutionized, and the new science of plant genetics has been established. Up to the time when Mendel's work, originally published in 1865 and practically lost till 1901, was republished, plant-breeding had been more or less a hit-or-miss process. Results *were* got some times but how they were got was not known. The science of plant genetics which was based on Mendel's work and which has now grown in quality, intensity, and range into something rather marvellous deals with the why and the wherefore of the inheritance of plant characters. Among these, the ability to resist certain fungoid diseases is a most important one for agricultural crops.

Wherever cotton is grown, it is subject to several fungoid diseases, and in America, Egypt, and India cotton wilt is one of the most severe. The term wilt is given because the external symptoms are of wilting or withering of the plant. The leaves droop as if the plants were not getting enough water, and finally die. As a matter of fact, the plants are *not* getting enough water because their water-carrying tubes are choked by coils of fungus threads which have entered into the roots through the fine root hairs from the soil. From the beginning, however, it has been claimed that different varieties and strains of cotton suffer different degrees of damage. This may sometimes be very striking. In any Government experimental farm in India where cotton wilt is being worked on, as you pass along the plots of various cotton varieties and strains, you will see in one plot practically every plant dead or dying and in a neighbouring plot it will be difficult to pick out one or two per hundred that are even slightly affected. Straightforward selection amongst plants which show this resistance has in the past given some very satisfactory results, particularly, when the progeny of such selected plants has been further tested by growing the seed on parts of the farm which have been deliberately infected by burying in it plants which have died of this fungus.

In the Bombay Presidency, for example, the cotton breeder at Dharwar had, previous to 1920, selected and developed a very admirable cotton which went under the name of Dharwar 1. After 1920, however, wilt became a serious problem and this excellent variety showed itself unfortunately very susceptible to the disease. The cotton breeder had, fortunately, amongst this repertoire of other strains a variety known as Dharwar 2 which was susceptible only to the extent of 2 per cent, in conditions when Dharwar 1 died to the extent of 50 per cent. This resistant variety was crossed with Dharwar 1, and the progeny of this was selected so that the good commercial qualities of Dharwar 1 might be retained and to them be added the wilt-resistant quality of Dharwar 2. In 1926 a suitable new variety produced by crossing these two parents was regarded as fixed. In 1930 it was given the name of *Jayawant*, meaning victorious, and it continues to justify its name. Selection against wilt by other cotton breeders in Bombay has also given the highly resistible Jarila, a new variety, being a selection from the Verum type of cotton in Khandesh. In Gujerat, Broach Desi 8 which is similarly very wilt-resistant has been the result of similar selection. In other provinces of India where wilt is a problem, similar work has been or is being done, and the work is largely financed by grants from the Indian Central Cotton Committee.

Cotton is not the only crop which suffers from wilt. Recently, in the Bombay Presidency, Sann hemp, which is important both as a fodder crop and still more as a green manure for sugarcane, showed itself susceptible to a severe attack of wilt. The Plant Pathologist at the Poona Agricultural College has now been able, by special methods, to produce a variety of Sann hemp that is completely wilt-resistant.

This brings us to the next point in our story, which is the development of a technique to isolate from strains of plants, which are already fairly resistant, sub-strains that shall be entirely resistant in the worst possible circumstances. These worst possible circumstances must be such that the fungus is artificially provided with the conditions in which it is most virulent and in which the plant is most susceptible. Such conditions can only be insured in specially arranged temperature tanks,which are large boxes of earth with the soil temperature artificially controlled by electric means and with proper humidity and infection. In such conditions many of the varieties which in the field show only 2 to 5 per cent resistance die out entirely, *i.e.*, they are 100 per cent susceptible and it was with just this important point of difference between field performance in these controlled conditions that an important discussion has been taking place amongst cotton scientific workers for the last year in India.

The final stage in this discussion took place at the first Conference of Scientific Research-workers on Cotton in India held in Bombay on the 4th, 5th, and 6th of March. During the previous months of discussion, there had been a healthy exchange of views, frank criticism, a pooling of information and a gradual approach to complete understanding which was finally ratified in what may be regarded as a statement of faith which the Conference passed unanimously at its meeting. The resolution was as follows :—

"This Conference agrees that the breeding of strains immune to wilt under optimum conditions is the ideal to aim at. For agricultural distribution, resistance of the order of 95% under heavily infected field conditions is satisfactory, provided that the strain has been tested and shown to be practically homozygous for that degree of resistance to wilt.

The Conference recommends that :—

(1) Test for homozygosity should be applied before a resistant strain is released for distribution,

(2) the Pathologist should also conduct tests for homozygosity and need only select in material shown to be heterozygous, and

(3) the conditions under which field tests are being carried out should be described and standardized as far as is practicable."

There are two words in this which may appear rather repellent to the ordinary reader. Concerning the word *homozygosity* (of which the adjective is *homozygous* and its opposite word *heterozygous*) a word or two in explanation is necessary, and this brings us to one of the contributions of the science of plant genetics to this problem.

It is now definitely known that a particular character in the plant is due to one or more genes. A gene is a little difficult to define, *i.e.*, it is difficult to define it as a thing, but its physical basis is probably some small physical portion of the protoplasm of the nucleus of each of the mating cells which produce the embryo within the seed. There are many of these genes, and it does not follow that each character is determined by only one gene. It has recently been shown that in many cases a character is determined by several genes acting together, and as the number of these vary, so does the intensity of expression of the character. It now seems likely that wilt-resistance is determined by a number of genes acting together. If there are a great many of these, the plant will be highly resistant in the field and may be also highly resistant in optimum conditions. If there are fewer of these, the plant may be still resistant in the field but will break down under optimum conditions of infection. If there are very few of these, the plant will also be highly susceptible in the field and of course in the optimum conditions as well. Now each gene has its opposite, *viz.*, resistance has as its opposite, lack of resistance or susceptibility, and since plants are often accidentally crossed in nature by wind or insects, it is possible that a plant may be hybrid for any character including wilt-resistance. If this is so, a wilt-resistant plant may *not* give progeny of the same level of resistance as itself. If a plant then is pure for a character such as a particular level of wilt resistance it is called homozygous for that character, and if it is hybrid or mongrel for that character it is called heterozygous. The important thing is to get homozygous material of a high degree of resistance and to this end both the field tests and the laboratory work will now be carried out.

Still another crop which suffers from wilt is linseed and important work on breeding of wilt-resistant varieties has been carried out at the Indian Agricultural Research Institute when located at Pusa. The list could be made much more exhaustive as regards wilt and, in conclusion, we may simply look at two other points. What is actually the physical nature of resistance to wilt by the cotton plant? So far as we can see, the mechanism appears to be something like this. The fungus in the soil may enter a root of resistant plant, but if the plant is really resistant, the fungus gets only a very little way into the tissues of the plant. In front of the invading fungus the tissues break down, resembling the tactics of a retreating force blowing up the bridges behind it. The fungus does not appear to be able to cross this gap and the gap is sometimes reinforced by the production of a corky layer preventing any further spread.

Another familiar example of resistance is that of wheat to rust. Some varieties are easily attacked by wheat rust which forms brown pustules on the leaves, stems, and even ears, while other varieties are less susceptible. But in wheat the problem is enormously complicated by the fact that there are several so-called physiological races of wheat rust. In cotton wilt, so far as we know, there is only one and for this we must be thankful. In the case of wheat, a variety may resist two or three of the physiological races and be susceptible to others. So far as we are aware, in India there are only five such physiological races but in America the number is nearer 150. Work on this important subject, *i. e.*, on the physiological races and the varieties they attack, has been done under the financing of the Imperial Council of Agricultural Research by Dr K. C. Mehta at Agra and Simla. The breeding of wheats, utilizing this knowledge, is being done all over India where wheat is grown, *e. g.*, by the Imperial Agricultural Research Institute at New Delhi, Karnal and Pusa, by the Agricultural Departments of the Punjab, Bombay, the Central Provinces and elsewhere. Here also considerable successes have been registered and in all these areas strains very suitable to the area and comparatively resistant to several of the physiological races are already known. But the work has got to go on until a higher degree of resistance is obtained to all the races known. In this connexion we have in India one very valuable wheat type, the so-called Khapli which appears to be resistant to four out of the five Indian physiological races of rust and is therefore a most valuable parent in crossing to get resistance.

The Cocoanut Palm

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THE cocoanut palm (whose botanical name is *Cocos nucifera* Linn) is plentifully cultivated throughout the tropical regions of Burma and India. It thrives well in saline or semi-saline soil, hence is more abundantly found to form gregarious formation near the sea coast. Most of the cultivated varieties of cocoanut flower during the summer season and the nut ripens during the months from September to November. In the Peninsular India, this palm maintains well its normal growth up to an elevation of 3,000 ft above the sea-level and in some parts of the Shevaroi Hills in South India it has been found growing well even at an altitude above 4,000 ft.

Cocos Nucifera Linn.

The area under cocoanut cultivation in Bengal starts from the coastal line of the Bay of Bengal to 100 to 200 miles inwards in the Gangetic basin. Under exceptional circumstances it may be seen to grow farther inward and, even in Assam, cocoanut is not of very rare occurrence. The Indian regions of the cocoanut cultivation may be said to be the lower basins of the Ganges and the Brahmaputra, and the Malabar and the Coromandel Coast. The altitudinal measure of cocoanut cultivation in the Brahmaputra basin is greater than that of the Gangetic. Of late cocoanut cultivation has made a rapid progress in the Islands of Laccadives and Maldives in the Arabian Sea and in the Andaman and Nicobar groups in the Bay of Bengal.

Cultivation : The area under cocoanut cultivation in India has been estimated at 4,800,000 acres.

Sowing : The ripe nut carefully collected should alone be employed as seed and for this purpose the nuts should generally be gathered during the months from February to June. Seeds from very young or very old trees should be avoided. About a month after plucking, the nuts should be planted. This should be done from January to April, or again in August, provided the rains are moderate. The seed beds should be dug 2 feet deep and the nuts planted 1 foot apart. The nuts should be laid on their sides leaving a portion of their surface exposed to atmosphere. Ashes or ashes and salt should be freely placed in the trenches—this acts both as a manure and as insecticide. The seed should be kept moist but not soaked. Transplantation may be done from the second month of germination up to a maximum of twelfth month. In some parts of Rampha District in Madras Presidency the transplantation is done after a period of 3 or 4 years. In moist regions transplantation should better be done during the summer season, otherwise during the rains.

Transplantation : The seedling should now be put on in the plantation pits 12 yards apart. In rich soil the pit may be very small; but in poor soil 1 to 2 yds wide and 2 or 3 ft deep. In cold clay soil these pits should be filled with sand. In marshy land, walls should be constructed around them. In poor soil, salt, ashes, paddy straw, fish manure, goat's dung and dry manures are found beneficial during the first year.

At the end of the first year the soil round the plants should be dressed and ash added, and in every succeeding year the soil should be opened and manured before the commencement of the rains.

Yield: A flowering spike of cocoanut yields from 10 to 25 nuts. The produce of a normal healthy plant may come up to 200 nuts per annum. The proportion of yield depends mainly upon the soil and the climatic conditions. The average yield of a cocoanut palm may be taken as 100 nuts per year. This palm may bear fruit up to 70 years.

Soil: The cocoanut thrives best in low, sandy situations, within the influence of sea breeze and never attains the same perfection when grown inland.

The soil suitable for cocoanut cultivation has been classified into 9 groups by Simmonds, as follows :—

"*a.* Soil mixed with sand, either dark coloured or river-washed.

b. Where sand is mixed with clay, ferruginous earth or black mould.

c. Clayey soils where the understrata consist of sand.

d. Sand and clay even when mixed with gravel and pebbles.

e. The seashore banks of backwaters, rivers, tanks and paddy fields.

f. Alluvium of rivers and backwaters, provided a yard and a half of land is to be generally seen above water-level.

g. Marshy land even in brakish soil (but not where salt is formed in crystals by evaporation.)

h. All level lands exposed to the sea breeze where the soil is good, such as the valleys between hills, tanks and ditches which have been filled up.

i. Lastly, even floors of ruined houses well worked up, any places much frequented by cattle and human beings on account of the ashes and salt of the ammonia from the urine, etc., deposited day by day in the soil."

Enemies of the cocoanut: *Batocera rubus*, a common beetle, with a reddish brown head, penetrates into the root and in the stem through the tissue and finally kills the plant. When attacked by these pests the leaves turn yellow and terminal bud withers. *Batocera* is prominent when the soil is too rich. In the Malay Peninsula another species of elephant-beetle is a deadly enemy of the palm. This beetle begins its attack from the leaf and finally into the folds of the shoots and thus kills the plant by destroying up the tissue. These beetles are extracted by the natives by means of long iron needle or fish-hook or by pouring salt or brine on the top of the tree. *Calandra palmarum*, a destructive beetle of rather a dangerous type, enters the stem and bores round holes and lives there. Rats, flying foxes, and squirrels injure the tree and sometimes kill it by eating away tender terminal bud or cabbage.

Dye: Every part of the plant, especially the husk enclosing the fruit, yields a kind of dirty brown colour. The dye may be extracted by cold or boiling water or by solutions of lime, potash, and ammonia.

Coir Fibre: The thick pericarp of the outer wall of the fruit yields the valuable coir fibre of commerce. The sheaths of the leaves are used to wrap up articles. The coarse coir fibre is mainly used in commerce for the manufacture of rope. "The fibre is tough, elastic, springy, easily manipulated within certain limits, eminently suitable for manufactures where lightness, cleanliness and great indestructibility are required. It will stand water and is almost impervious to wind and wave or to damp and rain." (G. Watt)

Oil: The sliced kernel, dried at ordinary temperatures, either in the sun or artificially, contains from 30 to 50 p. c. of oil. The methods of extracting this oil in India is as follows :—

The kernel is boiled with water for a time, then grated and squeezed in a press. The emulsion thus obtained is next boiled until the oil is found to rise to the surface. The ordinary commercial oil is expressed by rude oil mills worked by oxen.

The oil is white and nearly as fluid and limpid as water in tropical climates. It has a sweet taste and, according to some, an agreeable odour when fresh, but is liable to become rancid in a short time. In Europe the oil is chiefly used in the manufacture of candles and soaps. In India it is employed in cooking, and as a medicine when fresh for burning, in painting, soap-making, and anointing the body, when rancid.

Medical Uses : *Fruit* : "The water or milk of the unripe fruit is described as a fine-flavoured, cooling, refrigerant drink, useful in thirst, fever and urinary disorders." (U. C. Dutta). Even when taken in quantity it is non-injurious and is considered a purifier of blood. It is commonly believed in Bengal that too much cocoanut milk induces a hydrocele, swelling of the scrotum. The pulp of the young fruit is nourishing, cooling, and diuretic. The pulp of the ripe fruit is hard and indigestible, but the milk obtained by squeezing it may be used as a substitute for cow's milk. It is employed with beneficial results in debility, incipient phthisis, and cathertic affections, in doses from 4 to 8 ounces twice or thrice daily. In large doses, it proves aperient and in some cases actively purgative : hence it is suggested by Mr Wood as a substitute for castor oil and nauseous purgatives.

Shell : "The cleared shell of the nut or portions of it are burnt in fire, and while red hot are covered by a stone cup. The fluid which is deposited in the interior of the cup is rubefacient and is an effectual domestic remedy for ringworm." (U. C. Dutta). It is also highly esteemed in itches and scabies.

Oil : Oil is used as an application in burns and in baldness. Cocoanut oil is said to promote the growth of hair, hence it is much used as a local application in alopecia and in loss of hair after fevers and debilitating diseases. The oil is given in plethora and as a vermifuge in Jamaica. It is given while fasting, warmed and with a little sugar, in flux. An emulsion of the oil and kernel is prescribed in coughs and pulmonary diseases generally. Attempts have been made in Europe to use cocoanut oil as a substitute codliver oil but met with little success. Its indigestibility is a great drawback to its general use.

The freshly drawn juice of this palm is believed to possess refrigerant and aperient properties. The outside scrapings of the husk and branches applied to ulcers will cleanse and heal them rapidly, if soaked in proof rum. The young roots boiled with ginger and salt are efficacious in fevers.

Cocoanut cotton, found in connexion with the lower parts of the branches, is used for stopping blood in cases of wounds, bruises, leech-bites, etc.

"The sweet today obtained from this palm is very refreshing and possesses laxative properties. Its continued use during pregnancy has a marked effect on the colour of the infant, which is born of fair complexion." (P. Kinsley. Madras).

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The Origins of Art

Elie Lebasquais

(Translated by **Ananda K. Coomaraswamy***)*.

THE problem of the origins of art can be approached from two sides, *viz.*, from the historical and from the logical points of view, which are at the same time inseparable and complementary. On the one hand, one can try to determine the date of the first appearance of actual artefacts; this is the method of prehistoric archaeology. On the other hand, one can study the genesis of art in the human spirit, apart from any question of dates; this is the method of aesthetics.

These two disciplines are connected in such a way that each and every historical solution implies its logical counterpart, and *vice versa*. Thus the older beliefs about human prehistory were deduced from traditional aesthetics, while at the present day aesthetics is only an appendage to official archaeology which assimilates primitive man to the "savage" and the child. We shall approach the problem from the historical angle, postponing to another occasion the criticism of modern aesthetics.

To place the appearance of art in the sequence of time, we must first agree about a series of considerations having to do with various periods of prehistory and the primitive state of man; which considerations can be most conveniently clarified from the position we have chosen, that of the origin of art. If there is one error more than another by which modern ideas, in every field, are falsified, it is certainly that of "progress."[1] Now in art this word has no meaning. One cannot say that there has been any progress as between a bison drawn in ochre by a Magdalenian artist on the walls of the Altamira cave, and a hare by Pisanello, or even a lion by de Barye. Art sets human works on a plane of continuity, equality, and incessance, which liberates the modern mentality from its greatest obstacle to its understanding of the successive cycles described in traditional teachings. Art does not progress. Its origin is always actual, because this origin lies beyond the psychic. There is no need to be a child to begin; a real artist is always beginning. One is an artist only at this price. This almost amounts to a definition of an artist.

Freed from this prejudice we are in a better position to understand some facts which are still disturbing to students of prehistory; for example, the relative superiority of the older palaeolithic races in the matter of sculpture; or the brutal decadence, and virtual disappearance of Magdalenian art at the dawn of the neolithic period, just when there appeared a new race, less endowed artistically, but "more highly civilized"—a problem actually insoluble by archaeological science, but easily to be explained by the traditional teachings.

The whole secret lies in the idea we form of "primitive man." It is difficult, almost impossible, for the modern mind to separate what a man *is* from what he *has*, his being from his property; difficult to understand that property, the whole material of civilization, can only prosper at the cost of being, and that therefore modern "civilization" is a monstrous excrescence that has robbed man of his innermost substance—materializing it above him as a heavy load, around him like a prison, in him as an infection, from which the inevitable and necessary breakdown of this civilization will set him free, to be sure, but in a state of privation and only half alive.*

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[1] Cf. A. Gleizes. *Vie et Mort de l'Occident Chretien* (Life and Death of the Christian West), p. 60: Two words, 'barbarism' and 'civilization' are taken for granted in the development of our historical ideas. By introducing notions of relative inferiority and superiority, these two words qualify the idea of 'progress' with just that aspect of continuity that we long for in each special field of investigation. They relieve us of all anxiety about the future: 'barbarism' having been left behind, and 'civilization' improving every day." (Tr.)

The autonomy and self-sufficiency of primitive man is inconceivable to us.† The absolute independence of a man who is sufficient for all his own needs and in possession of all his powers because he is still consciously attached to his fostering and fertile source; the indefeasible and invisible dominion of such a person surpasses the understanding of a "civilized" being, who puts himself in the same position, and supposes himself degraded to a state of bestiality, alone, weak, poor, and naked—a position in which he may perhaps find himself tomorrow, though he certainly never lived in such a state in the past.

To understand the life of those men, clothed with skins of animals and easily nourished by the fruits of the earth, one must allow them by way of compensation and balance, a spirituality all the higher because it was not inhibited by external devices. This condition corresponds to what is still the state of pastoral peoples, and to that of the patriarchs who recite the Bible and the Koran, the dogmatic content and formal perfection of which are incompatible with the modern theory of "primitive man."

It is true that plastic art such as we are now considering will only "develop" later on in the time of agricultural and sedentary neolithic man and that of the builders of cities to whom, as has been justly said, the whole of "civilization" can be attributed.

But already in the days of wandering and early nomadism—more "natural" than the later sedentary way of life—even when tradition rested still on those sublime heights of knowledge of which the Bible and the Vedas have preserved diminished and misunderstood reflections plastic art played its part in every activity, it was and still remains the symbolic formulation of a thought.[2]

It may be said further, from the present historical point of view and neglecting absurdities, that the discoveries of prehistoric science, so far from contradicting traditional doctrines, can only be fully and really explained by means of these very doctrines.

If we try to prove this, the first requirement would be to draw up a table of exact equivalents between the ancient and modern chronologies, between, for example, the chronology of the Hindu tradition and the chronology at present adopted by archaeologists. Tilak, author of an often quoted book, *The Arctic Home in the Vedas*, already attempted to draw such a parallel. But since modern science is as variable as error itself, and the dates nowadays accepted go much further back into the past than was the case when this Hindu author was writing, it is wiser to refrain from renewing his attempt and to content ourselves with some broader generalizations.

It is fairly easy to harmonize in a general way the sequence of the different *manvantaras* with the cosmic revolutions succeeded by glacial periods, as nowadays recognized by geologists. It is probable indeed that the beginning of the present *manvantara* corresponds to the last glacial period contem-

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*The "spread of civilization" is often identified in so many words with the arousing of "new wants" in "backward people", and regarded as a blessing conferred upon the latter in this very sense. This point of view is actually merely an excuse for the commercial activity of "opening up new markets". So far from the proposition holding any element of truth, the fact is that the fewer a man's wants, the less he depends on material accessories, the higher may become his form of being; and per contra, the more wants, the less liberty, for as the *Chāndogya Upanishad* (VIII. I. 6) expresses it, "men are the servants of their such and such requirements". (Tr.)

†The "higher" the "civilization", the weaker the man. As a well-known American Indian author has remarked, "The utter helplessness of civilized *man* as a whole when in the woods, even under the safe condition now obtaining (is not realized)....and under the drastic conditions obtaining in those earlier days he would likely not have lived above a week". (Tr.)

[2] Cf. Andrae, W., *Die Ionische Saule*, Schlusswort: "Study for once the representations of the whole fourth and third millennia B.C. in Egypt and Mesopotamia, contrasting them with such 'ornaments' as are properly so-called in our modern sense. *It will hardly happen that even a single 'ornament' can be found there.* Whatever may seem to be such is a drastically indispensable technical form, or it is an expressive from, the picture of a spiritual truth." (Tr.)

porary with what archaeologists speak of as the lower palaeolithic.

The *origin* of art in the material sense in which we are here speaking cannot be pushed farther back than this. Nothing human, except only the mysterious biological germ that presides over a fresh renaissance, could actually have crossed the gulf of the last cosmic catastrophe.

Art properly so called appears in much later strata, at the upper palaeolithic level, in the Aurignacian, Solutrean and Magdalenian periods, which would thus refer it to the middle of the present *manvantara.* The more recent Azilian period would impinge on the *Kali Yuga* ; and with the appearance of neolithic man—our immediate ancestor—we find ourselves in the very long historical period which extends from predynastic Egypt to the bronze-age Celts.

To this very general distribution in time must be added a situation in space. We should, so to say, make a map of these vanished civilizations which have left us engravings on the surfaces of rocks as their only signatures.

Now it is only Europe, or rather only Western European countries, that have been excavated methodically and continuosly for some time. How then can prehistoric science dare to pass judgment without having all the evidence before it? How can one imagine the civilization of these undoubtedly nomad peoples as if they had been sedentary, and judge of these immigrants from an unknown fatherland as if they had been natives; how can we judge of them merely by the traces of their passage through three or four little European countries? Even supposing that every country of the globe had been excavated, how can we deny the possibility of the foundering of whole countries beneath the rise of post-glacial oceans, at a time when the outline of the continents and the climatic curves did not, perhaps, obey the same laws as now? If we adopt the theory of an arctic origin of the primordial tradition and consequently nordic origin of the peoples supported by this tradition, how can we fail to distrust the conclusions of a science which has to take as the foundation and basis of its speculations excavations made outside the arctic circle, the centre of the primordial home, just where excavation is virtually impossible? *

But this is not all. The picture of the poverty of prehistoric science is more surprising still. Not only are its sources of information limited by difficulties of excavation and lack of investigators, but still more restricted by the natural wear and tear of things. We recognize a really alarming paradox: periods and civilizations which were almost entirely founded on the use of wood, a material that has obviously disappeared, are now called palaeo- and neolithic, in other words are described as "ages of stone". Suppose, now, we were actually in possession of the stone tools of these periods, we should still have at our command nothing but the exceptional material, and of a tiny percentage of probabilities from which nothing could be deduced with any certainty

Finally and notably, even if the manner of life of these peoples could be restored to us in its entirety, by a miracle analogous to that which preserved Pompei, nothing would have been accomplished, errors of all kinds would still be possible and would actually be incurred. Just as in the case of those objects that have actually been preserved, there would still remain the last and most difficult step to interpret them. The "decoration" of utensils is really only the trace of a vanished thought, and if the tradition of this thought is lacking, no observation, no hypothesis, no comparisons with Esquimaux or Australian or children's art will reveal the secret of what is really a lost language.

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* We observe in a newspaper, dated Sep. 20 1935, a dispatch from Moscow that confirms our argument: "The Samoyede peninsula was formerly highly populous, as appears from discoveries made in the Ohorsk region (in the Polar circle) at the mouth of the Ob, the great river of Siberia. The archaeological expedition which worked there for seven months has collected about two thousand objects, of earthenware and bone. Some are unique. Most of these objects are ornamented with engraved designs representing animals. Amongst the most interesting are combs with five prongs intended for high coiffures; and some curious spoons in mammoth bone. The archaeologists also found bronze objects, and primitive crucibles made of shell and intended for the casting of metal, and still retaining traces of mineral; agricultural implements; and bones of animals and birds long extinct in the Samoyede peninsula. The discoveries prove considerable density of population in a region where one now hardly finds one or two inhabitants every five or six miles".

We should have of necessity to return to the light shed by the different traditions on the nature of art, in order to understand its ritual and symbolic origins and to grasp its role as the support of a ceremonial and as the fixation of a dogma. Prehistoric art would then seem to be, like all other and even more than any other art, only the surviving fragment of a whole, of which the main part, the thought of the men who created it, is lacking to us, and must remain so.

Let us at least, in conclusion, try to say something about this possibly double role of prehistoric art. The most remarkable and oldest monuments are the decorated caves of the upper palaeolithic. Now, if we consider the complicated organization of the passageways that lead to these shelters, which remind us inevitably of the Cretan labyrinths, if we reflected that in all probability they were never actually inhabited, and reexamine the animal decorations, the human hands plastered on the walls, and note the regular absence of human representations (apart from little praying silhouettes analogous to the "orantes" of the Christian catacombs), we cannot help believing that these places were a sort of natural temples, initiatory sanctuaries or chapels in which funerary ceremonies were performed.

The dolmens or covered passages of subsequent period are, then, just artificial reconstructions of the primitive caves, made in countries where the natural caves were no longer in use or indeed had never existed. Archaeologically speaking, the dolmens thus form a link between the palaeolithic caves and the domed "tombs" of the Myceneans.

Later on geometrical ornament, very reserved in the older periods when symbolic expression had a more "naturalistic" aspect, will overspread the megaliths, menhirs (ancestors of our sundials and obelisks) and cromlechs (stone circles, crosses, swastikas, simple and double spirals, solar images, and conventionalized pictographic signs, which can only be interpreted as a sort of writing.

It is really impossible to separate language, writing, and drawing in their beginning. Their appearance is simultaneous, just as their symbolic and phonetic roles are coincident. Primitive Egyptian hieroglyphics and the oldest Chinese characters convince us of this.

At the end of these brief pages, what appears in our picture of prehistoric art? Temples, tombs, observatories, inscriptions. Is not this precisely the very list of monuments that the most finished civilizations still provide for our consideration?*

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*Translated from *Etudes Traditionelles*, Vol. XLI, 1936, pp. 168-174, by Ananda K. Coomaraswamy. A few of the original notes have been omitted. Added notes are marked (Tr.).

Hydro-electric Practice in India

The Hydro-Electric Practice in India.—*By Bhim Chandra Chatterjee, B. A., B. L., B. Sc., M. I. E. (Ind), M. I. E. E., F. R. S. A., Patiala Professor and Head of the Department of Electrical Engineering, Benares Hindu University. Published by Shiva Narayan Chatterjee B. Sc., 1 Laksha Road, Benares-Vol. I. p. 579 with 55 plates, 116 Illustrations and 92 photographs, Vol. II, p. 596 with 160 plates, 34 Illustrations and 95 photographs. Price – Rs 50 or 85 shillings net for both volumes.*

It is not probably realized that the advancement of human civilization is mainly due to man's ability to command larger amounts of power for his use. Domestication of animals like the horse and the elephant gave men greater power than those who relied on their own muscles or on slaves and utilization of forces of nature during the middle ages, such as windpower, or power from running streams, gave such communities who were first in this field greater power than those who relied on older methods. In the present times, the problem of supply of power has been revolutionized by the invention of power engine and the advent of electricity. The consumption of electricity per capita may be taken as a measure of the country's prosperity and of civilization. Let us therefore examine the position of India. In the most advanced countries of the world the consumption of power per head amounts to about 2000 units (in Canada). The position of India may be gauged from the fact that the consumption of power in India per head is only 6 units. It is mainly due to to this reason that India does not make much progress in modern life and has remained more or less in the mediaeval state.

What is the cause of this deplorable state of affairs ? It may be due to either of the two possible situations, (*i*) India is poor in power resources or (*ii*) though such resources exist they have not been developed. Let us examine the point a little more in detail. The sources of power are either coal, oil or power of running water. Some countries in the world like the United Kingdom possess huge coal deposits, but very little hydro-electric power resources ; other countries like Norway, Switzerland and Italy have no coal or oil, but plenty of water power ; while a few like the U. S. A. have got both coal and water power. But whatever resources any country has, it has developed these to the fullest extent, otherwise they cannot stand in the struggle for existence. The coal and oil resources of India are very poor. They are mainly concentrated in eastern India, in the Bengal and Chota Nagpur regions. The other parts of India are to depend mainly on the development of hydro-electric power. Fortunately there is no dearth of this power in India. Sir M. Vishweswariya estimates in his book *Planned Economy* that the total hydro-electric power available in India amounts to 2 millon killowatts of which barely 3% has been developed. While Japan is also poor in coal and oil resources the Japanese State, by a well-planned series of actions has developed 80 per cent of the available power, with the result that the power available per capita in Japan is above 300 units. Though this falls far short of the consumption of power per capita in the Western countries (United Kingdom 500 per capita, U. S. A 900), yet it is much higher than that of Soviet Russia or that of Mexico or Latin America. By the use of this power, Japan has been able to put her industries on a proper basis, and is able to compete in the world market. But if the hydro-electric resources of India were developed to the same extent as in Japan the consumption of power per head would come to about 200 units and India would attain the standard of Japan. The development of hydro-electric power has therefore great future in India and whatever Government may come in power, they have, sooner or later, to tackle this problem, if they ever want to develop industries in India.

In view of these facts, the two sumptuous volumes by Professor B. C. Chatterjee of the Benares Hindu University are greatly to be welcomed. The first volume deals with the general principles of hydro-electric development, *viz*, Feasibility of any hydro-electric scheme, Hydraulic layout, Hydrology, Mesurement of water power, Hydraulics, Economical development of water power, Elements of hydro-electric plants, Dam, Conduits, Turbines, Regulating devices, power house ; and valuable suggestions on care, operation and management have been made throughout and troubles generally occurring in various parts and their remedies described. In fact the first volume is meant to be not only a text book for the advanced hydro-electric engineer, but also a reference book for the practical engineer and those interested in the development of industry. The chapters are written with great care and a great wealth of material has been condensed in this volume. While going through the book it appeared to the reviewer that Professor Chatterjee will do well in the next edition to rearrange the matter and give more attention to a literary presentation in some parts.

The second volume deals with the description of the various hydro-electric stations and substations with accessories now operating in India. The volume closes with a short but interesting chapter on management and operating records. This will be very useful to those who want to undertake hydro-electric schemes in future in this country, as the whole subject has been finely illustrated, and a wealth of information has been collected which will be of great use to those actively engaged in this branch of engineering.

A critical study of these two volumes reveals certain facts which ought to be noted by those who are interested in the future development of this country. We have said in the beginning that only 3 per cent of the hydro-electric power in India has been developed. The remaining 97 per cent still remains to be developed. It is therefore necessary that we learn by the experince and the errors of the past. The words "hydro-electric power" sometimes act like magic on ill-informed public men and industrialists. They are under the impression that if hydro-electric power can be developed, they will get power with very little expenditure. This is not a fact, on the contrary, electrical machinery has now been so much improved that wherever coal resources are available, development of power has always proved to be more economical. Even close to the Niagra station, which is very famous as the first large hydro-electric power station in the world, other power stations run on coal are competing very successfully with power derived from this famous hydro-electric station. In some places, though companies were floated with the expectation of hydro-electric development, coal power has been found to be more economical, and the companies though using coal power wisely kept silent. Owing to the great improvements in the design of steam-turbines, the cost of producing power out of coal has been reduced to one-fourth. On account of the great development in transmission of electricity over large distances (as in Russia and Germany) electrical power has successfully been transmitted to a distance of about 300 miles from the generating station, the cost of transmission and supply has been enormously reduced. On the other hand, the reduction in cost of installation of hydro-electric stations has not been so great for dams, conduits and other necessities for water storage and water regulation must be constructed, and these are civil engineering operations which cost much the same to-day as they did fifty years ago. It has been found that wherever coal resources are available, they should be developed rather than hydro-electric power. So it will be more economical to manufacture electricity out of coal power in eastern India, consisting of Bengal, Behar, Orissa and Assam. Electricity may be generated at the mouth of coal pits as in England and distributed by a well-planned grid system over the whole country. But as there are parts of India like the United Provinces and the Deccan and the Western Presidency where no coal is available, they must develop their water power resources if they want to take to modern life. This is being tried for the last twenty years and let us see with what success. Hydro-electric power can be developed from a fall of seven feet as at Renala in the Punjab, up to a gross head of 3080 feet as is obtained at Pykara. They require huge capital outlay and very good planning for success.

The story of hydro-electric development as told by Professor Chatterjee is unfortunately a sad one. The cost of installation per killowatt of power has varied from Rs 125/- Rs 3500/- in the case of Mandy scheme. The Renala scheme, it may be noted, was a private enterprise of the late Sir Ganga Ram, the well-known engineer and philanthrophist of the Punjab. Sir Gangaram took on lease a large plot of barren land, developed it with hydro-electric power, and handed it back to the Government after termination of the lease as a garden land flowing with prosperity. This scheme cost the least and has been the most profitable. The Kaveri scheme and the scheme of the Tata Company cost about Rs 500/- to Rs 600/- per killowatt installed. One of these schemes was a State scheme, and the other was a scheme taken by a private company. Let us come to the scheme which has been furthered by the Government of India or Local Governments. The Mandy scheme fathered by the Government of the Punjab cost Rs 3800/- per killowatt. It holds world's record for high cost. Yet in 1933 when the scheme was opened, the then Viceroy unnecessarily grew eloquent on the topic, described it as a monument of great engineering skill. Those who have followed the development of this schme cannot but be impressed with the fact that whatever is tried by the Government is turned into coal, the Mandy scheme stands as a living monument of gross mismanagement, jobbery and highest cost of installation causing ultimate bankruptcy to the province. This scheme for which the tax-payers of the Punjab were told that the total cost would be Rs 2 crores, ultimately cost nearly 11 crores of rupees. There are many other ambitious schemes floated in different provinces, it is hoped that people will learn by example of the Mandy scheme and will not be charmed by the mere word of hydro electric development. Another, similar to the Mandy scheme is the Ganges canal Hydro-electric scheme. Both in the Mandy scheme and the Ganges canal Hydro-electric scheme the cost of production of a unit is 9 to 11 pies while Kavery and Sreenagar and Jammu produce a unit at a cost of 1.183 and 2.8 pies respectively and the coal fuel stations in U. P. produce a unit at a cost of 4 to 5 pies per unit.

Professor Chatterjee's book will serve as a mine-house of information for all those who are interested in this subject. It ought to find its place in all Indian libraries and the libraries of such persons who are interested in the development of power in this country.

AN INSTRUMENT FOR AUTOMATICALLY GUIDING A TELESCOPE

A mechanism for automatically guiding an astronomical telescope during a long exposure has been developed in the Astronomy Department of the University of Wisconsin. The light from a star in the field enters a photo-cell after undergoing division by a roof-shaped mirror, and periodic interruption by a rotating shutter. The resulting alternating current from the photo-cell is highly amplified, and by use in an electric motor along with a second supply of alternating current characterized by constant amplitude and phase, is made to drive the plate holder in the proper direction to remove any accumulated error. The instrument has been tested on both the ten-inch photographic and the sixty-inch reflecting telescopes of the Mount Wilson Observatory, with satisfactory results. It was found that by using a star of magnitude 8.5 or brighter the automatic guiding of the sixty-inch telescope was at least as good as that done manually.—*Public. Astr. Soc. Pac.*

Disposal of the Dead at Harappa

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IN his recent paper on 'Vedic Funeral Customs and Indus Valley Culture' Dr B. N. Datta[1] indentifies the peoples of the first stratum of the cemetery at Harappa practising jar burials with the Vedic Aryans. The detailed report of the skeletal remains of Harappa has not yet been published and it is too early to draw any conclusion on them. Regarding the antiquity of the jar burial stratum of Harappa, Sir John Marshall[2] is of the opinion that it belongs to a much later age but the archaeological evidence has not yet been fully cleared up as yet.

The present writer had the privilege to spend one full excavation season at Harappa in 1930-31 and to examine all the cemetery remains found at Harappa till then.

The cemetery at Harappa has been dug up to three distinct strata. The first or the topmost stratum of the cemetery contains jar burials; the second complete burials; and the third or the lowest has yielded animal bones[3] only. Almost all the burial jars contain fractional burials and before the skeletons were put into the jars they were undoubtedly exposed; for the mouth of the jars is invariably too narrow to allow an entire human body to get through it. That the dead bodies were exposed before they were put into the jars is further apparent from the fact that the bones of more than one individual are often found in the same jar. The presence of these bones of a second individual appears to be unintentional in these cases—the dead bodies must have been exposed in a particular spot, wherefrom in the process of carrying the deed bodies for the purpose of putting them into the jars, bones of various individuals may have stuck together. These however, can be differentiated from the jars where the remains of two individuals have been intentionally buried and as in the majority of cases these, appear to contain children's skeletons it is not impossible that the adult skeletons found along with them were those of their parents. A large number of jars have also been found without any bone whatsoever, probably the few pieces of bone having been completely decomposed. Lastly, that the dead bodies were first exposed to the birds and animals is evident from the fact that not a single complete skeleton has been found in any of the jar. As far as my personal knowledge goes I have come across only two jar burials with a few fragments of charred bones. From the very large number of jars found with unburnt bones it does not appear that the people of the first stratum practised cremation. The long bones were usually found to hedge round the skull which was placed in the centre. The dead bodies of children were always found in embryonic position and the present writer enumerated ten such burial jars and they were all found to be below two years of age. There is, therefore, no doubt that the people of the first stratum practised fractional burials after the dead bodies were exposed on the ground.

The second stratum has yielded complete burials. Here the dead body is laid either on the spine or to one side and in a large number of cases accompanied by funeral pottery. That some animal bones were intentionally placed along with the dead body has been distinctly proved by the discovery of a skeleton, excavated by the present writer, accompanied on the side by the badly severed skeleton of a sheep or goat. A part of the animal's rib was placed in the crossed hands

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1. Datta, B. N. - *Man in India*, *16*, 223-307, 1936.
2. Marshall, John - *Mohenjodaro and the Indus Civilization*, London, Vol. 1, P. 89, 1931.
3. Prasad, B.-Animal Remains from Harappa, *Mem. Arch. Sur. India*, No. 51, Delhi, 1936.

of the dead man. Another such instance was found where a piece of animal bone was actually found on one of the earthen dishes placed alongside the dead. In addition to these two cases, most of the open burials which were lifted in the earlier seasons were accompanied by some animal bones. It appears that there was no fixed method of orientation of the dead body; the dead bodies have been found with the head in almost all the directions. It was previously held that no skeleton was found with the head to the west and therefore, any skeleton which was discovered during the excavation with the head to the west was believed to belong to the local Muhammadans and reburied with all courtesy to the departed. The discovery of the skeleton along with the sacrificed animal by its side and its head to the west, accompanied by a group of funeral pottery of the Indus Valley type near the feet, in February, 1931, finally settled the question. Since then, the present writer has also removed two skeletons, which had their heads to the west and one at least has proved to be a very interesting type of Armenoid skull. The other skeleton, which has unfortunately been reburied, appears to the author to be a case of floor burial and it took him four complete days to expose the skeleton. It was found in trench IV of Mound F below the second stratum of building layers, and a terracotta ringstand, which is usually used for keeping store jars on the floor of the house, was lying about a foot above the head of the skeleton. The head was detached from the spinal column and lay about six inches apart from the body and there cannot be any doubt regarding the antiquity of the above skeleton. A second lot of human remains was also found in the same trench, which forms part of the Harappa collection. The latter had no skull along with it although some bones of the upper extremity and a right tibia were found. The first skeleton thus supports the contention of Sir John Marshall[4] that floor burial was in vogue in Mohenjodaro. The stray bones as mentioned in second lot, found in Trench IV, Mound F, among building sites appear to have been carried by birds and animals when the dead bodies were left exposed and they should not always be treated as fractional burials.

To come back to the cemetery again. Towards the fall of the 1930-31 season the cemetery was extended to the north[5]. Here the first stratum yielded the same type of jar burials but the second stratum, which towards the southern side had been yielding complete burials, opened out a number of fractional burials only. The type of pottery accompanying the bones was, however, similar to that of the southern end. It thus appears that at this period there was some sort of disturbance which affected the burial customs of the second stratum people. The northern extension was found to cease at this end as the walls of the building were exposed and the total area of this extension was probably less than one-fourth the area of the main cemetery. The people of the first stratum, as can be guessed from the skeletal materials and the burial jars, were much larger in number than the people of the second stratum. The results of excavation at this end suggests, in my opinion, a period of clash between the two people and it appears that the people of the first stratum dominated over the people of the second stratum. The latter seems to have left their last trace at this corner of the cemetery and they had to leave the cemetery to the people of the first stratum here. In this extension the number of funerary pottery are fewer than those found in the main cemetery. Remains of only five individuals have been identified from the skeletal materials and none is completely represented by the bones. They appear to be the remnants of the individuals killed in their struggle with the first-stratum people although the fractional nature of the burials is very much striking. It appears rather improbable that the first-stratum people prevailed upon those of the second stratum, being their conquerors, to adopt the fractional burial. It may be that these individuals were not so carefully buried as the others in the main cemetery, because if they were really engaged in a warfare they could hardly pay any attention to the killed.

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[4] Marshall, *op. cit.* Vol. I, P. 80.

[5] *Op. Cit. Annual Report*, II, Pl. XXVI, (b).

It thus follows that the people of the second stratum did not practise any exposure before burial and unlike the people of the first stratum, who used to make fractional burials, they practised complete burials. The methods of disposal of the dead of the two peoples are, therefore, entirely different. The people of the second stratum who appear to be contemporary with the late Indus Valley Period, therefore, did not practise cremation and this goes against the theory of Sir John Marshall[6] that cremation was the likely method of disposal of the dead in the Indus Valley during Chalcolithic times. The evidences of post-cremation burials are meagre and both at Mohenjodaro and Harappa the complete burials have been found in the majority, which seems to be the prevailing mode of burial in the Indus Valley.

That there was a clash between the peoples of the first and second strata also appears to be corroborated by the human remains from G site. The presence of a large number of human and animal bones in a refuse manner, which cannot in any way be called a burial, also supports the above contention. It seems that the dead bodies were thrown in a dump in this spot after the warfare. Further, the racial types represented in some parts of G site and in the second stratum of the cemetery appear to be closely related[7].

At present we cannot say anything definite regarding the people of the first stratum. As has been pointed out by Dr B. S. Guha[8], they indicate the presence of a different race and possibly a different culture. It is certain that their cultural remains will be dug up some day. Coming to Dr Datta's identification of the above people with the Vedic Aryans, the first difficulty lies in the fact that even if we consider the jar burials as similar to the urn burials of *Griha-Sutra* the custom of exposing the dead bodies to the wild animals and birds before the skeletons were put in the jars has not been known to be in vogue among the Vedic Aryans. Further, as can be understood from the descriptions of the jar burials given above, the remains of burnt skeletons are exceedingly rare, although Dr Datta speaks of it as if it was the general practice. It is too premature to enter into the controversy of the racial types before the Harappa and the second Mohenjodaro reports (by Dr Mackay) are published and in view of the facts stated above regarding the disposal of the dead at Harappa there cannot be any justification for Dr Datta's contention that the jar burial people of Harappa were identical with the Vedic Aryans.

Lastly, Dr Datta considers that Dr Guha, in his *Census Reports* (Vol. I, pt. III), has confused the date of the advent of the brachycephalic Dinaric race in this country[9]. But he does not appear to have carefully gone through the report. Dr Guha[10] speaks of the advent of this race in the Hindu Kush regions to be later to their dislodgment from Russian Turkestan by Mongol invasion. The penetration of this race in the N. W. Himalayan region, as exemplified by the Wakhis in recent years must not therefore be confused with the advent of the brachycephalic race with "Armenoid affinities" during the Late Indus Valley Period at Harappa, from which apparently the people of the Peninsular and Eastern India are to be traced. There are undoubtedly close affinities between the two, but whereas in Sind and the Lower Punjab we can trace this race during the Chalcolithic times, its penetration across the Indian frontiers in the Hindu Kush regions from Russian Turkestan is a comparatively recent movement which is still continuing and is not to be confused with ancient drift of a closely allied race in the Lower Indus Valley.[11]

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[6] Marshall, *op. cit.* I, P. 89.

[7] Marshall - *op. cit.* I, P. 108.

[8] Guha, B. S. - *Racial Affinities of the Peoples of India,* Vol. I, Pt. III, A, p. lxviii.

[9] Datta - *op. cit*, P. 266.

[10] Guha - *op. cit*, p. xxi.

[11] Guha, - *op. cit.* p. Lxxi.

Notes and News

Note on the Nutritive Value and Cost of Red Palm Oil

Red palm oil is derived from the fruit of the West African palm *elaeis guineensis*. This palm has been imported into Malaya and Burma; in the former country it appears to be extensively grown, but not as yet in the latter. It has not yet been introduced into India.

A number of workers have shown that red palm oil is very rich in carotene, the precursor of vitamin A, and that it can supply the vitamin A requirements of rats when given in very small quantities. Hitherto, however, it has not been conclusively proved that carotene can fully replace vitamin A in the diet of human beings. Nor has its effect in cases of keratomalacia been observed; it seemed possible that, in such cases, efficient transformation of carotene into vitamin A might not take place. It was therefore felt desirable to carry out clinical test of red palm oil before taking steps to encourage its production and consumption in India.

Lieutenant Colonel R. E. Wright, working in Madras, reports that red palm oil is as rapidly effective as cod liver oil in treatment of human keratomalacia. In a number of cases rapid improvement took place in cases which remained living under the identical domestic conditions in which they had developed the syndrome, the only change in their daily routine being the addition of red palm oil emulsion to their diet. In addition, the progress of cases in hospital on red palm oil and cod liver oil was carefully compared.

If red palm oil cures keratomalacia, then its carotene must be capable of satisfying the daily vitamin A requirements of human beings.

Red palm oil is obviously a valuable potential source of an important vitamin. It is, however, difficult to make a satisfactory estimate of its probable cost should it come to be used on a wider scale as a medicine or a dietary ingredient. Red palm oil, shipped in bulk from Singapore, costs at present about 180 Straits dollars per ton. This would work out at approximately 2 annas per pound. Cod liver oil in India costs from 10 annas to Re. 1|- per pound. Allowing for differences in vitamin A activity per unit of weight, the following very rough comparison of cost can be made:—

If the cost of red palm oil and cod liver oil is taken as about 2.5 annas and 12 annas per lb. respectively, the amount of vitamin A activity purchasable for a given sum in the form of red palm oil will be about 8 times greater than that purchasable in the form of cod liver oil.

Clearly red palm oil merits attention on the part of the agricultural authorities and nutrition workers in the Tropics and the East. It could be widely used as a substitute for cod liver oil in hospitals, dispensaries and children's homes. The fact that, unlike cod liver oil, it contains very little or no vitamin D, is not necessarily a drawback to its use in countries where vitamin D is supplied by abundant strong sunlight and rickets is rare. In India, it could be used in the South and other parts where vitamin A deficiency is common and vitamin D deficiency not a serious problem. It might also be consumed as an ordinary ingredient in the diet, perhaps mixed with other vegetable fat devoid of carotene. It is used by the natives of West Africa as a culinary oil in much the same way that butter and various vegetable fats are used in Europe. In the Coonoor Laboratories it has been found that palatable mixtures of vegetable oil (*e.g.*, cocoanut) and red palm oil, containing carotene in such proportions that the vitamin A content of the mixture is roughly equivalent to that of good butter, can be prepared. Some destruction of carotene takes place on heating such mixture, but enough remains to be of value. It might be feasible to prepare a palatable "margarine-like" product based on a mixture of hydrogenated fat and red palm oil.

The question of introducing the palm *elaeis guineensis* into South India should receive attention on the part of agricultural authorities. The climate of South India would probably be suitable for its cultivation.

Indian Historical Records Commission

The Government of India have re-appointed the following gentlemen as corresponding members of the Indian Historical Records Commission for three years for the centres mentioned.

	Name	Centre
1.	Sir Edward Denison Ross, Kt., C.I.E., Ph.D., Director, School of Oriental Science, London.	London.
2.	Sir William Foster, Kt., C.I.E.	„
3.	Mr W. T. Ottewill, M.B.E., Superintendent of Records, India Office, London.	„
4.	Sir Evan Cotton, Kt., C.I.E.	„
5.	Mr K. A. Nilkanta Sastri, M.A., Professor of Indian History and Archaeology, Madras University.	Madras
6.	Mr M. Venkatarangaiya, M.A., Reader in History, Andhra University, Waltair.	Waltair
7.	Mr C. V. Chandrashekharan, M.A., (Oxon), F. R. Hist., Director of Public Instruction, Travancore.	Travancore and Cochin
8.	Rani Laxmibai Rajwade.	Gwalior
9.	Rao Bahadur Sardar M. V. Kibe, M.A.	Indore
10.	Shrimati Kamalabai Kibe.	„

Foreign Delegates to the Science Congress Jubilee

It has been announced that the following foreign scientists are likely to visit India next winter to attend the Silver Jubilee session of the Indian Science Congress which will be held in Calcutta from January 3 to 9. These names have attained international reputation. Lord Rutherford, the Director of the Cavendish Laboratory, Cambridge, will preside. Sir Arthur Eddington (Plumian professor of Astronomy, Cambridge University), Sir Arthur Hill (Director, Royal Botanic Gardens, Kew), Professor C. G. Darwin (Master of Christ's College, Cambridge), Prof. G. P. Thomson (professor of Physics, Imperial College of Science and Technology, London), Prof. P. G. H. Boswell (professor of Geology, Imperial College of Science and Technology London), Dr C. S. Myers (Principal, National Institute of Industrial Psychology, London), Dr W. G. Ogg (Director of Macaulay Institute for Soil Research, Aberdeen), Prof. H. J. Fleure (professor of Geography, Manchester University), Sir Arthur Harden (Late Head of Biochemical Department, Lister Institute of Preventive Medicine, London), Prof. Lennard-Jones (professor of Chemistry, Cambridge University), Prof. Ruggles Gates (professor of Botany, King's College, London), Prof. N. M. Comber (Head of the department of Agriculture, Leeds University), Dr C. D. Darlington (Lecturer of Cytology, University of London), Prof. F. E. Fritsch (professor of Botany, Queen Mary College, London), Prof. C. E. Tilley (professor of Mineralogy and Petrology, Cambridge University), Prof. J. L. Simonsen (professor of Chemistry, University College of North Wales, Bangor), Prof. C. E. Spearman (Emeritus professor of Psychology, London University), Prof. H. H. Read (professor of Geology, Liverpool University), Lt.-Col. R. B. S. Sewell (Zoological Laboratory, Cambridge University), Sir J. C. Irvine (Vice-Chancellor, St. Andrews University), Prof. A. L. du Toit, Prof. F. Von Eickstedt (Director, Anthropological Institute, Braslau), Prof. L. Diels (Director, Botanical Gardens, Berlin), Prof. W. Straub (professor of Physiology, Munich University).

Wood vs. Steel for Framed Buildings

Both practice and theory indicate clearly that the most efficient and economic type of earthquake-proof and storm-resistant structure is the framed type. The question that arises is whether a very rigid frame type that obtained with steel is superior to the more flexible type obtained with wood. An answer to this problem has been attempted in the pamphlet entitled *Wood vs. Steel for Framed Buildings* issued by the Forest Research Institute, Dehra Dun, and the answer is of considerable importance to Northern India which is definitely in the earthquake zone.

That a flexible type of structure is the least dangerous in earthquakes is supported by actual insurance statistics. It is also the conclusion of experts in the United States of America and Japan. An authoritative report on the Long Beach earthquake disaster of 1988 states that "there was no proof of any particular advantage of the so-called rigid frame design over flexible design." Based on the experience gained in the disastrous Japanese earthquake of 1923, Mashima, the famous earthquake specialist, has definitely indicated his preference for a flexible type of construction. His final conclusions are that wood-framed structures are the most reliable of all the economical types of structures known at present.

In a comparison of any two types of construction, the points that matter are relative cost, effect of weather, safety against fire, heating economy, maintenance and repair charges, adaptability and acoustics, and considered from all these aspects, treated timber structures offer definite advantages which cannot be claimed by its rivals.

Thus, to give a few instances, American experience has shown that the cost of a steel-framed construction is about 50 per cent more than that of a corresponding wood-framed construction. In India it would appear that the corresponding figure is likely to be about 60 per cent. As for the relative effect of weather, the long, satisfactory and extensive use of timber for frame-work houses in the past demonstrates that this factor need not be seriously considered if proper precautions are taken. From the point of view of safety against fire, the insurance rates of several insurance companies in England which show that wood-framed houses can be insured for exactly the same low rate of 1s. 6d. per £100 of the initial cost of a house as for steel-framed masonry houses, give the decisive answer.

It may well be asked whether a steel-framed building is not usually stronger than a wood-framed structure. The answer is, says the Forest Institute, that all depends on the design of the two types under construction. If properly designed, both are equally strong. Weight for weight wood is as strong as steel—a fact that many do not appreciate. Again, in the matter of heating economy, a wood-framed building has definite advantage over a steel-framed house, for steel conducts heat 300 to 400 times as rapidly as wood, so that heat passes very rapidly to the interior of the building from outside. A simple calculation will show that in a Quetta winter, for instance, about 2 tons more of coal will have to be burnt every year to offset the extra loss due to the higher conductivity of steel-framed construction.

Further, if properly preserved and seasoned timber is employed, maintenance will be no more costly for timber-framed structures than for steel-framed ones, while in adaptability the wood-framed building is ideal for making alterations and additions because wood can be sawn, jointed and reinforced very easily. The effect of the two types of construction on the acoustics of a house is another point which may be of interest to house-owners. The Bureau of Standards of the United States of America made, some time ago, an exhaustive investigation of the sound transmitted by partitions built of different materials, and it was reported that the loudness of sounds of average pitch transmitted by metal lath and plaster partitions was nearly 15 per cent greater than that of sounds transmitted by standard wood lath and plaster partitions.

Indian Science Congress

For the occasion of the Silver Jubilee session of the Indian Science Congress, to be held in Calcutta from January 3rd—9th, 1938, certain Sections have been split up, and three new Sections thereby created. The complete list of Sections with their Presidents is as follows:—

Section	President
1. Mathematics and Physics	Dr C. W. B. Normand, Director General of Observatories, Meteorological Office, Poona, 5.
2. Chemistry	Prof. S. S. Bhatnagar, Director, University Chemical Laboratories, Lahore.
3. Geology	Mr. D. N. Wadia, Offg. Supdt. Geologist, Geological Survey of India, 27, Chowringhee, Calcutta.
4. Geography and Geodesy	Dr A. M. Heron, Director, Geological Survey of India, 27, Chowringhee, Calcutta.

SECTION	PRESIDENT
5. BOTANY	Prof. B. Sahni, Professor of Botany, Lucknow University, Lucknow.
6. ZOOLOGY	Prof. G. Matthai, Professor of Zoology, Government College, Lahore.
7. ENTOMOLOGY	Mohammad Afzal Husain, Principal, Punjab Agricultural College, Lyallpur, Punjab.
8. ANTHROPOLOGY	Dr B. S. Guha, Zoological Survey of India, Indian Museum, Calcutta.
9. AGRICULTURE	Rao Bahadur T. S. Venkatraman, Imperial Sugarcane Specialist, Lawley Road, Coimbatore.
10. MEDICAL RESEARCH	Sir U. N. Brahmachari, Kt., 82|3, Cornwallis St., Calcutta.
11. VETERINARY RESEARCH	Col. A. Olver, Animal Husbandry-Expert, Imperial Council of Agricultural Research, New Delhi.
12. PHYSIOLOGY	Brev. Col. R. N. Chopra, Director, School of Tropical Medicine, Chittaranjan Avenue, Calcutta.
13. PSYCHOLOGY	Dr G. S. Bose, University College of Science, 92, Upper Circular Road, Calcutta.

Under the new rules of the Association, the abstracts of papers will be printed in final bound form before the meeting. *The Executive Committee have therefore fixed August 15th as the last date for the submission of papers and abstracts.*

Since it is desirable that a very high standard should be maintained on the occasion of this session, the Executive Committee have decided that *no abstracts will be printed unless accompanied by the full paper at the time of submission,* thereby enabling the papers to be refereed by the Sectional Committees.

Regarding the Botany Section, Prof. B. Sahni, the President, has divided his section into six sub-sections, with separate Chairmen. He asks us to request intending contributors to send their papers direct to the Chairman of the appropriate sub-section, who will act as referee and advise the President. The following are the six sub-sections:—

SUB-SECTION	CHAIRMAN
CRYPTOGAMS	M. O. P. Iyengar, Professor of Botany and Director, University Botanical-Laboratory, Madras.
PHANEROGAMS AND TAXONOMY	S. P. Agharkar, Ghose Professor of Botany and Head of the Dept. of Botany, University of Calcutta.
GENETICS AND CYTOLOGY	Dr (Miss) E. K. Janaki Ammal, Geneticist, Imperial Sugarcane Station, Lawley Road, Coimbatore.
MYCOLOGY & PLANT PATHOLOGY	K. C. Mehta, Prof. of Botany, Agra College, Agra.
PHYSIOLOGY AND ECOLOGY	P. Parija, Prof. of Botany Ravenshaw College, Cuttack:
PALAEOBOTANY	B. Sahni, Prof. of Botany, University of Lucknow.

As far as possible the meetings of the sub-sections will be held consecutively, in a continuous programme, so as to avoid their overlapping with each other.

The following is the suplementary list of delegates who have accepted the invitation to attend the Jubilee Session of the Indian Science Congress:

Bally, F. G., (Edinburgh), Bally, E. C. C., (Liverpool); Blackman, V. H., (London); Caie, J. M., (Edinburgh); Debenham, F., (Cambridge); Fearnsides, W. G., (Sheffield); McFarlane, J., (Aberdeen); Ogilvie, A. G., (Edinburgh); Rendle, Dr. A. B., (London); Saunders, Miss E. R., (Cambridge); Stratton, F. J. M., (Cambridge); Venn, Dr. J. A., (Cambridge); Wynn Jones, Dr. Ll., (Leeds); Barker, E., (Bambridge); Crew, F. A. E., (Edinburgh); Howarth, O. J. R., (London).

Science in Industries

British Empire Fair and India

Final reports on the annual British Empire Fair held in London recently show that India increased her representation and, as a result, attracted more orders. According to a report just received from the Trade Department of the High Commissioner for India in London, exhibits of goods from India occupied 3,786 sq. ft, an increase of 300 sq. ft over last year. This time there were 20 separate stalls with exhibits of 65 firms, compared with 16 and 53 respectively of the previous year.

The amount of business done in the form of orders booked at various stands was Rs 63,185, which was 40% more than last year's figure, and 68% more than the year before, as shown below:

	1935 Rs	1936 Rs	1937 Rs
Coir and Fibre Goods	Nil	4,000	8,900
Carpets and rugs	8,000	10,650	13,200
Brassware	22,400	15,000	11,672
Inlaid and carved woodwork	2,300	1,870	4,500
Lace	2,100	3,330	2,070
Sports Goods	2,700	8,240	14,580
Furs and Skins	Nil	2,000	Nil
Kashmir work	"	Nil	670
Embroideries and Silks	"	"	1,985
Cigars	"	"	900
Miscellaneous (Hats, Oohre, Oakum, etc.)	"	"	4,658
Total	37,500	45,090	63,185

Of the orders booked 68 were from new customers, while 26 new connections were formed for fancy goods and artware (including 1 from Australia and 1 from France) 2 for lace, 14 for sports goods, 3 for carpets (including 1 from France and 1 from Australia) and 6 for silks (including 3 from France). All these were sample orders which might be repeated if they proved satisfactory.

Commenting on the drop in orders for brassware, the report remarks:—

"It might be due to various causes, amongst which might be mentioned: (*i*) connection having already been established, the buyers placed their orders direct with the manufacturers; (*ii*) such a vast variety of fancy goods answering modern taste and requirements was on the market that the field of choice was considerably widened to the detriment of the old fashioned Indian brassware; and (*iii*) the quantity received this time, though it consisted of individual samples of variegated designs and styles, was far too much for the size of the stall, which made it impossible to exhibit all the samples to advantage, with the result that the buyers could not see them all within the limited time at their disposal. If less quantity but more select varieties had been received, perhaps better business might have been done. However, though the total value of the orders received was less than before, a number of new connections were formed".

A similar explanation for the drop in the orders for lace is also given.

It is noted that the King and Queen and other members of the Royal Family visited the India stands and made a number of purchases. The cost of participation totalled £1,498 against £1,065 of the previous year, the increase being due to more space having been taken.

Timber for Development of Communications

All-weather rural roads are an important part of any rural reconstruction programme. But how to have them? The answer is given by the Forest Research Institute at Dehra Dun, which in one of its pamphlets entitled *Treated Timber Bridges for Indian Highways and Railways*, says that the treated timber bridge holds the key to the problem. For four or five months in the year a considerable length of rural roads lies useless and villages served by these roads are cut off from urban areas. It is the absence or lack of efficient and economic type of highway bridges which partially cause these difficulties. Many engineers not aware of what the Forest Research Institute has been able to achieve in this direction will probably think that timber is not exactly the type of material from which durable bridges of this kind can be made. But the Institute which as a result of recent researches has evolved a type of material and design of construction that are a great improvement over timber bridges known to most engineers and administrators of India at present, says that if a good wood preservative and an efficient method of preservative impregnation are employed, one can confidently expect a life of at least 25 years with practically any timber which should preferably be in the round if installed in the ground. Poles of sal, teak and other similar species, treated with an efficient preservative, says the pamphlet, would provide excellent material for building durable railway and highway bridges in most parts of India at considerably less expense than with steel, masonry or concrete. According to provisional calculations an average saving of 30% to 50% in the initial cost of the bridge can be effected by using treated wood. Treated timber thus affords to the tax-payer practically two bridges where only one can be had at present without at the same time sacrificing even ultimate economy.

Bridge spans of over 100 feet are possible with properly designed timber trusses, for use on highways and even on railways. Spans up to 850 feet are practicable if the suspension bridge type is employed. There is also a field open to the timber trestle bridge type. 70 to 90 per cent of the total length of railway bridges of several important systems of railways in the United States of America are of treated timber. It may also be news to some people that the longest railway bridge in the world is built of wood. Among the notable examples of treated timber highway bridges that have been installed recently in other parts of the world, is the Howe Truss Bridge at Fresnal, British Columbia. It has two spans of 150 feet each and three spans of 180 feet each. Another timber bridge erected recently is the eighty feet span warren truss railway bridge designed to withstand Cooper's E.50 loading, put up three years ago in the United States of America. The Government of the United States of America have also built in 1934 a treated Douglas fir suspension bridge of 845 feet span over the Rogue River in Oregon State. Several highway bridges of 80 to 120 ft span have also been built during the last two or three decades in Germany and Switzerland and they are still rendering efficient service.

As regards the durability of treated timber bridges, service records of several thousand railway and highway bridges in the U. S. A. (where in most States conditions tending to destroy timber are hardly less severe than in India) afford a ready and definite answer. In a State where untreated timber hardly lasts two years, the 6½ miles length of the longest trestle bridge in the world located in the Southern Pacific Railway system over Lake Ponchartran has remained practically intact for over 55 years, during which period only about 6% of the original timber has been renewed. In India a period of more than 20 years' durability has been obtained with readily perishable soft woods in the form of sleepers after they were treated with wood preservatives. Other tests with wood preservatives conducted by the Forest Research Institute, Dehra Dun, during the past 25 years have shown that treated wood resists white ants and rot in India as effectively as it does in other countries such as the U. S. A.

The Institute will be glad to give all possible help to engineers regarding the design of this type of bridges, in addition to any information required concerning the efficient and economic treatment of timber with preservatives.

Weights and Measures in Bombay

A Bombay Government communique says that soon after the introduction of the Bombay Weights and Measures Act, 1932, it became evident that the weights and measures mentioned in the first schedule of the Act were not sufficient for all the requirements of various trades in the Presidency. The Government, therefore, took steps to get the Act so amended as to empower them to declare as standard either generally or for any trade or class of trades, weights and measures, multiples and submultiples thereof. After carefully considering representations from various bodies, a large number of new weights and measures have now been recognized.

In January number of SCIENCE AND CULTURE, we published an article on "Standardization of Weights and Measures" in which it was shown that in India the state of affair has been made uselessly complicated by allowing the use of British system side by side with the important systems prevalent in various parts of the country and in various trades. We expressed the view that Metric system being the most rational system and having been adopted in practically all the civilized countries of the world should also be adopted in India and necessary legislations passed. We are therefore sorry to find that the Bombay Government, instead of simplifying down the whole thing by adopting the Metric system, has complicated the situation further by recognizing a whole lot of new standards. Some idea of the complexity may be gathered from the list of weights accepted as standards given below. For convenience we have omitted the list of liquid measures, a very large number of measures for special trades, area, volume and length.

Weights already recognized

The Bombay Tola of 180 grains.
The Bombay Seer of 80 tolas.
The Bombay Maund of 40 seers.
The sub-multiples ½, ¼, ⅛, 1/16 and 1/32 and the multiples, 2, 4, and 8 of the total, seer and maund.

The pound avoirdupois equal to 7,000 grains and the sub-multiples ⅛, ¼, ½, 1, 2, 4 and 8 ounces, the multiples 1, 2, 4, 7, 14, 28 lbs. (a quarter), 56 lbs., 112 lbs. (1 cwt.) and 2,240 lbs. (1 ton).

Dry Measures:—

The Bombay seer.
The sub-multiples ½, ¼ and ⅛ seer.
The Bombay Chatak=1/16 seer.
The Adpao=⅛ seer.
The Adholi=2 seers.
The Bombay payali of 4 seers.

The Bombay Maund of 16 payalis.
The Bombay Map of 2 maunds.

Weights now recognized

The dram is equal to 1/16th part of an ounce or 1/256 part of a lb.

Sub-multiples—⅛, ¼, ½ of dram and multiples, 2, 4, 8 drams.

The grain and sub-multiples—.01, .02, .03, .05, .06, .1, .2, .25, .3, .5, .6, and multiples 2, 3, 4, 5, 6, 8, 10, 12, 16, 20, 24, 30, 48, 50, 60, 72, 100, 120, 240.

Dry Measures:—

Sub-multiple 1/32 seer.
Sub-multiple ⅛, ¼, ½, ¾ of Bombay Maund.

Chemists and Industry

The Society of Chemical Industry held a symposium at Manchester on April 2, on the "Induction and functions of the chemist" and "His influence and reward." The meeting was well-attended and many speakers, including several experts from leading chemical firms of Great Britain took part. It is interesting to note from the discussions that the problems in Great Britain in many respects strikingly resemble those in India. Thus, according to *Nature* (April 17, 1937), the following points have emerged from the symposium:

(*a*) For certain classes of work, graduate chemists do not appear to be sufficiently trained in manipulative technique, possibly through the attempt to put too much into the curriculum.

(*b*) There has been too little contact between industry and the teaching institutions generally.

(*c*) There is a large demand for chemists whose training from the start is along definitely technical as opposed to purely academic lines.

(*d*) For success in other walks of life, such as administration, business, salesmanship, and even finance, chemical training forms just as good background as any other.

The Coal-Tar Dye Industry with Reference to India

This month we publish an article on the next page on "The Coal Tar Dye Industry with reference to India" by Mr K. L. Roy. The industry in this country has immense possibilities in future, and the article will be much appreciated, we hope, by our readers.

The Coal-Tar Dye Industry with Reference to India

Kanai Lal Roy
Ghose Research Scholar in Applied Chemistry, University College of Science, Calcutta.

The origin and development of the coal-tar dye industry represents one of the greatest triumphs of modern chemistry. In 1834 Runge discovered phenol and aniline in coal-tar. The researches of A. W. Hofmann (1842-68) revealed the chemical nature of several of the more important constituents of coal-tar. The industry practically dates from 1856, when Perkin obtained mauve by oxidising aniline. In 1859 Verguin isolated Fuchsine. Soon afterwards aniline-blue was discovered, which Hofmann in 1868 showed to be a derivative of rosaniline. In 1868 and 1869 Graebe and Lieberman synthesized alizarine from anthracene. In 1871 Baeyer discovered the phthaleins. In 1876 E. and O. Fischer worked out the constitution of rosaniline colours. About the same time the manufacture of the azo-colours was begun. In 1884 the congored cotton dyes were introduced. Indigo was synthesized by Baeyer in 1880, but its manufacture only became a commercial success after Heumanns' synthesis in 1890, the product being placed on the market by the Badische Anilin-und Soda-Fabrik in 1897. In recent years the most noteworthy dates are 1901, the year of the discovery of the first anthracenevat dyes by the Badische Anilin-und Soda-Fabrick and 1905, when thio-indigo was produced by Frieeländer.

Although the dye industry was founded in England by Perkin, who established a factory for the manufacture of mauve, and later of alizarine, the trade soon went into German hands, one of the weighty reasons being the unfortunate divorce of science from industry which largely prevailed in England, whereas the contrary was the case in Germany.

Since the manufacture of the artificial colouring matters from coal-tar, the use of natural colouring matters of animal and vegetable origin which have been used for dyeing for thousands of years has enormously decreased. A few, however, still possess some importance, *viz.*, indigo and logwood. There is no doubt in course of time the use of the natural colouring matters will become still less, being replaced by superior and cheaper synthetic products.

Coal-tar is the primary raw material of colour industry. It has an extraordinarily complex constitution, which varies not only with the nature of coal distilled, but also with the temperature of distillation. The constituents employed in the colour industry are benzene, toluene, xylene, napthalene, anthracene, phenol and cresol. The average percentages of these constituents in coal-tar are:[1]

	Per cent by weight of coal-tar
Benzene	0.6-1.0
Toluene	0.2-0.4
Xylene	0.2-0.8
Napthalene	2.0-10.0
Anthracene	0.2-0.4
Phenol	0.2-0.7
Cresol	0.5-0.8

These products from coal-tar are then subjected to various chemical treatments so as to produce intermediate products, which serve as raw materials for the production of final dye-stuffs. The chemical treatments mainly consist of sulphonation, nitration, reduction, oxidation, diazotisation and subsequent boiling with water, fusion with alkali and so on. The number of artificial dye-stuff is very large, thousands of different types of dyes having been produced up till now.

The establishment of the dye-stuff industry in our country has now become a fundamentally important problem. If we consult the statistics we shall find that of all the imported chemical products the coal-tar dye-stuffs top the list. The following is a list of some of the main imported chemicals, other than dye-stuffs, which we consume annually with approximate values (Table I):

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[1] *Vide*, Hooper, Analysis of Tar, *Jour. Soc. Chem. Ind.*, 29, 1438, 1910.

TABLE I

Imported Goods	Approximate Value Rs
Explosive chemicals ..	.. 25,00,000
Raw and manufactured asbestos	.. 14,00,000
Fire Bricks ..	.. 2,00,000
Cements (mainly from Japan and United Kingdom)	.. 20,00,000
Candles	.. 42,000
French Chalk ..	.. 6,000
Acetic Acid ..	.. 1,50,000
Carbolic Acid ..	.. 80,000
Citric Acid ..	.. 1,00,000
Hydrochloric Acid ..	.. 15,000
Nitric Acid ..	.. 60,000
Oxalic Acid ..	.. 1,00,000
Sulphuric Acid ..	.. 25,000
Tartaric Acid ..	.. 1,25,000
Alum	.. 50,000
Ammon. Carbonate and Bicarbonate	.. 1,50,000
Liquid Ammonia ..	.. 2,50,000
Ammon. Chloride ..	.. 3,50,000
Bleaching powder and other Bleaching material ..	.. 12,00,000
Calcium Carbide ..	.. 6,50,000
Ferrous Sulphate ..	.. 14,000
Copper Sulphate ..	.. 8,00,000
Disinfectants ..	.. 6,00,000
Sodi. Bicarbonate ..	.. 7,00,000
Sodi. Dichromate ..	.. 3,00,000
Sodi. Carbonate ..	.. 50,00,000
Sodi. & Pot. Cyanide ..	.. 11,00,000
Caustic Soda ..	.. 85,00,000
Sodi. Hydrosulphite ..	.. 8,90,000
Sodi. Hyposulphite ..	.. 67,000
Sodi. Silicate ..	.. 2,60,000
Sodi. Sulphide ..	.. 2,00,000
Glycerine	.. 3,50,000
China clay ..	.. 8,00,000
Patent Medicine ..	.. 60,00,000
Saccharin ..	.. 2,00,000
Earthenware & porcelain	.. 40,00,000
Glue and Gelatine ..	.. 4,50,000
Carbon Electrodes ..	.. 2,00,000
Rectified Spirit ..	.. 40,00,000
Denatured Spirit ..	.. 8,00,000
Paint & Varnish ..	.. 80,00,000
Soaps	.. 30,00,000
Starch and Dextrin ..	.. 35,00,000
and so on	

As against this, the import of coal-tar dyes approximates more than two and a half crores of rupees, and in the pre-war period (1913-14) the value of the imported dyes was slightly over one crore of rupees (114,81 lakhs).

Table II will explain the present position concerning the import of different classes of dye-stuffs and Table III indicates the share that different countries take in the export of dye-stuffs to India and the amounts of goods taken by different provinces of India.

From these tables it is clear that there are vast possibilities for the dye-stuff industry in India Now-a-days India produces about thirty million gallons of coal-tar. this raw material is not at all sufficient to manufacture all the dye-stuffs that are now imported here, but it is sufficient to start a new dye-factory with. And it is judicious at the beginning to start with naphthalene and anthracene as raw materials for colour manufacture, as they can be very easily separated from distilled coal-tar oil. It will be noted from Table II that anthracene and naphthalene dyes are imported to the value of about half a crore of rupees.

It is true that the chemical methods of the manufacture of coal-tar dyes are closely protectd by numerous patents. Nevertheless a beginning must be made and if we start manufacturing now, there is no reason why Indian chemists will not be able to find out cheaper methods within a relatively short time, which will enable them to take their own patents.

In this connection it is necessary to stress the point again, which has been referred to the May number of Science and Cultute, *viz.*, the need of close co-operation between the industrialists and the scientific departments of the universities. The artificial dye-stuff industry is pre-eminently an industry, where scientific talents are of the greatest service. A correct method of approach would be for industrialists to get into touch with the universities and finance preliminary researches on this subject by giving generous research grants and scholarships tenable at

TABLE II.

Dyes from coaltar	Quantity. (lbs) Eleven months (1st. April-end of Feb.) 1934-35	1935-36	1936-37	Value. (Rs) Eleven months (1st April-end of Feb). 1934-35	1935-36	1036-37
Alizarine	3,422,133	2,095,051	2,226,679	23,36,409	14,14,080	14,50,645
Congo Red	2,373,259	2,390,995	2,230,046	13,61,869	13,43,288	12,30,840
Coupling dyes of the napthol group	7.25,165	930,584	603,790	22,02,269	24,85,974	17,20,745
Rapid fast colours	64.882	54,846	38,246	3,22,912	2,95,018	2,08,262
Bases	410,951	540,311	314,980	9,42,973	11,45,414	6,70,762
Other Salts	784,241	923,516	676,472	11,96,534	13,[illegible]8,367	10,84,909
Indigo	1,225.835	1,136,123	714,611	16,97,963	15,83,856	9,46,961
Carbazole blue	44,549	75,362	76,730	1,22,117	1,55,879	1,63,238
Paste	275,632	206,679	135,391	7,64,481	5,01,402	4,19,447
Powder	397,751	573,422	584,878	57,48,028	84,44,412	82,20,820
Sulphur black	2,700,633	4,091,686	2,835,273	8,58,853	11,12,095	6,19,914
Metaril yellow	636,994	616,550	795,008	5,61,186	5,80,708	6,07,324
Auraurine	..	16,516	280	....	24,335	337
Rhodamines	5,950	3,382	551	8.354	8431	2,025
Aniline Salts	285,292	233,226	214,401	1,18,252	87,374	83,925
Others	4.835,414	5,012,475	3,349,224	69,09,105	78,07,440	51,24,249

TABLE No. III

Countries from which the dye staff are imported	Quantity. (lbs) Eleven months (1st. April-end of Feb.) 1934 35	1935-36	1936-37	Value. (Rs) Eleven months (1st. April-end of Feb.) 1934-35	1935-35	1936-37
From United Kingdom	1,835,113	2,044,596	1,485,045	30,23,515	38,70,513	29,58,197
Germany	12,201,269	12,690,005	10,173,475	1,74,54,907	1,87,09,221	1,56,24,411
Switzerland	595,132	656,708	365,925	15,60,319	19,32,241	12,52,970
United States of America	914,489	1,296,678	738,022	9,76,015	13,03,329	7,11,277
Japan	1,131,384	1,281,227	1,040,084	9,70,974	11,38,028	9,46,189
Other Countries	1,011,294	931,515	999,007	11,65,575	13,59,741	10,11,359
Total	17,688,681	18,900,724	14,796,558	2,51,51,305	2,83,13,073	2,2[illegible]04,503
Share of imports by Bengal	1,169,733	1,640,600	1,231,268	19,08,410	25,53,146	20,56,806
Bombay	12,571,416	13,893,188	10,503,717	1,80,72,146	2,13,65,684	1,65,17,102
Sind	1,621,511	1,389,991	1,395,354	14,80,646	12,34,082	11,24,177
Madras	2,187,159	1,686,922	1,585,467	35,05,943	28,02,389	27,22,566
Burma	138,862	290,023	80,752	1,84,160	3,57,832	83,752
Total	17,688,681	18,900,724	14,796,558	2,51,51,305	2,83,13,073	2,25,04,403

the university laboratories. The German universities, it is well-known, were one of the most important contributory factors for the phenomenal development of the dye-stuff industry in Germany, which country still occupies the first place in this line.

Finally, it may be stated that every important country in the world has learnt to utilise its coal-tar. It may, indeed, be said that the country, which does not scientifically treat its coal and tar is hardly civilzed. It is a pity that we in India have not yet learnt what immense power and fortune lie hidden in coal, otherwise how can one explain the terrible waste that is being daily incurred by burning coal in stacks to produce coke and discarding the tar and gases? The tar, again, where it is manufactured, is not scientifically treated, so that we are tragically dependent on foreign countries for valuable and essential commodities derived from tar. The dye-stuff industry is intimately related with certain classes of the synthetic drug and explosive industries for the reason that these classes of essential goods are closely chemically related. That is why the dye-stuff industry occupies a prominent position in the life of any nation. During peace and war synthetic drugs are always important and they can be cheaply produced only where there is a flourishing dye-industry. Explosives are equally important during peace time for mining purposes and in war they are essential. It is well-known that during the last war the huge dye-stuff factories of Germany were smoothly transformed into factories for the production of poison gases and explosives, which gave Germany a decided advantage over the allied countries. The question of the starting of a dye-industry should, therefore, be immediately gone into by a committee representing experts and industrialists and if possible the Government. Competition between nations to-day is essentially a competition in science and its applications and it is time that the intelligentsia of India generally realised it.

ELEMENTARY PARTICLES

Prof. J. Chadwick, F.R.S., in his Kelvin Lecture (the 28th) to the Institution of Electrical Engineers last week, described the latest views on the constitution of matter which science has been able to formulate. The comparatively simple "Solar System" picture of the atom which, for a short time after the discovery of the electron, seemed to fit the facts, soon showed itself to be inadequate. To the proton and electron, the positron, or positive electron, and the neutron have been added; yet even so the list of elementary particles is incomplete and an object named the neutrino has had to be postulated. It appears to be just about as difficult to detect as the nineteenth-century ether, but for the time being at any rate it is convenient makeweight. Nor is it yet certain that the neutron and the proton are distinct entities—they may, it seems, be merely different aspects of the same thing—like electron which behaves as a particle or a wave according to where it is and how one looks at it. Altogether, it is all very baffling, and Dr Chadwick admitted that while we were now able to describe the constitution of the atom in a way that was impossible in Kelvin's time, we were still as far as ever from being able to *explain* it. In other words we have found out the movements of the dance and identified some, if not all, of the participants, but are still in the dark as to the originating cause. At both ends of the scale, in astronomy and in atomic physics, it is the same story. The frontiers of knowledge are being steadily pushed further back, but the key to the riddle of the universe seems to be as elusive as the pot of gold at the foot of the rainbow.

—*The Electrician*, April 30, 1937.

Research Notes

Nutritive Disorder due to Eggwhite

Early in 1927 Boas showed that when fresh crude eggwhite is dried an essential dietetic factor in it is destroyed. In the absence of this factor young rats develop a characteristic universal dermatitis accompanied by nervous disorder which is finally terminated by death. This factor X is present in fresh egg, yolk and white, in dried yeast, raw potato, potato starch and arrowroot, milk, blood serum, banana and in fresh spinach and cabbage leaves. She also showed that there is a relationship between the amount of dried eggwhite ingested and the amount of protective factor X needed to give protection.

Lease and Parson in 1934 produced similar dermatitis in chicks with a well-supplemented ration rich in eggwhite, and cured this by an extracted liver residue poor in vitamin B_2. The syndrome produced on eggwhite is therefore not due to vitamin B_2 deficiency.

Lease in 1936 performed concentration of the active factor in an extract designated as Extract A suitable for injection.

With the help of this extract Parson, Lease and Kelly (*Biochem. J.*, *31*, 424, 1937) conducted experiments to find what interrelationship exists between the amount of the factor necessary for cure and the amount of eggwhite.

The plan of the experiment was to produce a standard grade of the characteristic disorder in rats and chicks on ration containing fermented dried eggwhite and well supplemented with the commonly accepted dietary essentials; the potent factor being administered in graded portions either by intraperitoneal injections of Extract A or by combining this extract or potent food with the ration.

The authors conclude from the results of their experiment that the greater the concentration of eggwhite in the diet the greater the amount of the factor necessary to cure the disorder. They have also made the important conclusion that this nutritional disorder is metabolic in nature and is not attributable to a deficiency either in the diet or in the tissues of any factor of the vitamin B complex so far clearly characterized. It has not yet been demonstrated whether the protective factor is a vitamin or whether it is required in normal nutrition.

H. N. B.

A Simple Aromatic Oestrogenic Agent

Since the discovery and isolation of oestrone and other oestrogenic bodies in the urine of pregnancy, attempts have been made to synthesize them. These substances contain the phenanthrene nucleus, but Dodds and Lawson (*Nature*, *137*, 996, 1936) have shown that this nucleus is not essential for oestrogenic activity. Very recently (*Nature*, *139*, 627, 1937) the same authors have made the very interesting observation that even such a simple compound as *p*-hydroxy-phenyl ethyl alcohol is capable of producing very marked oestrus response. Even a much more potent substance has been found in *p*-hydroxy propenyl benzene (anol) which has been found to be of the same order of potency as oestrone itself. It is, indeed, remarkable that such a simple substance should approximate the natural hormone in potency. The observation of Dodds and Lawson has obviously great theoretical and therapeutic implications.

B. C. G.

Pithecanthropus Erectus

Professor Dubois has again revived the question of human affinities of *Pithecanthropus* (*Man*, January 1937) which has been subject to the criticisms of Professor Le Gros Clark in the April issue of the above journal.

Dubois is of opinion that the fossil skulls *Homo soloensis* is really human and proto-Australian and has nothing common with *Pithecanthropus*. The

Rhodesian man closely resembles Solo man and both of them are representatives of the most primitive type of the species *Homo sapiens* and distinct from *Homo neandarthalensis.* These are evident from the straight and slender limb bones, the peculiar nuchal plane of the occipital bone, low cranial capacity of the Rhodesian man. The strongly developed *arcus supraciliares* and a *torus occipitalis transversus* resemble those of anthropoid apes and some Australians. These marked features of the Rhodesian skull have also been found to be present in the recently discovered skulls from Ngandong. The cranial capacities of the Rhodesian, Australian, and Ngandong skulls agree fairly well and the author is of opinion that the proto-Australians of Ngandong in Java and Broken Hill in South Africa had a somewhat larger brain volume than the Australian aborigines of today.

Secondly, Dubois holds that *Pithecanthropus* is a giant gibbon, a view which Marcellin Boule held fifteen years ago. Dubois has found in the deeper shaft of the femur some structures entirely different from the human one and this betrays a muscular function and a locomotion, which though erect and humanlike on the ground was also arboreal. This has been supported by the four femora found in 1930 and a fifth found in 1935 from Kedung Brubus, 24 miles east of Trinil. The gibbonlike appearance is furthur evident from the absence of *sinus frontale* in the gibbon and its marked developments in *Pithecanthropus*, and the volume of the cerebrum which is exactly twice that of an imaginary siamang gibbon with the body weight of *Pithecanthropus* as computed from the chief dimensions of the femora. Finally Dubois explains the surprising brain volume as due to some law—the law of progressive cerebration by great leaps (mutations). Professor Le Gros Clark (*Man*, April, 1937) on the other hand has pointed out the definitely human characteristics of *Pithecanthropus.* Speaking of the volume of the cerebrum on which Dubois has lain the greatest stress Clark says that such an out-tanding contrast would keep *Pithecanthropus* far removed from the gibbons in its evolutionary status. The law of progressive cerebration is based on quite inadequate observations on the relative brain weight of a few related groups of mammals and even if the thesis rested on sound evidence there can be no ground for inferring kinship between two animals. The cranial capacity of *Pithecanthropus* according to Dubois is 900 c. c. and that of *Sinanthropus* skull I, as estimated by Weidenreich is 915 c. c., but Dubois does not hold the latter to be a gibbon. The human status of *Pithecanthropus* is furthur proved by the convolutional pattern of the frontal lobes and the association areas are incomparably more extensive than the apes. Furthur, the marked asymmetry of the occipital lobes is a character which is reached in human brain only. Dubois' conclusions regarding the femur is based upon some indefinite markings as the changes of the femur due to arboreal habits have not been yet conclusively proved. The relative lengths of the condyles and the convexity of the popliteal surface is similar to modern femora. The cerebral growth of *Pithecanthropus* had attained definitely to a human level of development and this is supported by the major characters of the femur and by important dental characters. The similarity of the *Pithecanthropus* calvarium and its endocranial cast to those of *Sinanthropus* is so close that they belong to a common genus of primitive man.

S. S. Sarkar

Circular Ornaments of France

Two circular ornaments were collected from Loiret in France by E. Viot. They are now on exhibition in the Hall of Stone Age of the Old World in the Field Museum of Natural History, Chicago. These types of stone discs are rarely found in France. The thickness of both the discs is 1·5 cms while the diameter of the former is 15 cms and that of the latter 12·5 cms.

Henryfield of Chicago suggests a ritualistic use from the delicate and skilled workmanship of these discs. Capitan draws attention to similar ritualistic stone discs from Japan. He furthur adds that they are also similar in form of the Mexican divinities. Moreover jade discs worn by certain Buddhistic priests "play the role of fibula." Examples of shell discs also occur in New Hebrides, New Guinea and Gilbert Islands.

Minendra Nath Basu.

University and Academy News

Royal Asiatic Society of Bengal

An ordinary monthly meeting of the Royal Asiatic Society of Bengal was held on the 3rd May, 1937.

The following paper was read :—

1. A. H. Harley—*The Child-world and the Child in Araby.*

General introduction : the older psychology rarely features the child in sculpture or painting, and does not cater for him in literature till a late date ; recognition of the play-instinct is comparatively recent.

A number of games played by children in the Arab tribes are here illustrated from the oldest literature : *e.g.*, Mock Fights : the Whirligig or Saw ; 'Conkers' ; Tip-cat ; the Spinning-top ; Pebbles and Holes ; Hand-ball ; etc.

The following exhibits were shown and commented upon :—

1. M. Hidayat Hosain.—*Kitāb al-I'lān ; a very rare and original manuscript in the Society's collection.*

This manuscript is a combination of six treatises on different branches of Arabic learning in one work. When it is read in the usual manner it deals with the jurisprudence of the Zaidi sect of Islam, but when a page is read from top to bottom, which is divided into five columns in red ink, each column deals with five branches of Arabic learning, *viz.*, (2) Prosody and Rhyme, (I) Syntax, (3) Etymology, (4) Logic, and (5) the correct pronunciation and the various readings of the text of the Qurān. The author of the work is Shihāb ad-Dīn Ahmed bin 'Abdallāh as-Sallami and it was composed in A. H. 1115 (A. D. 1703). No other copy of this work is known.

2. M. Hidayat Hosain.—*Arabic biographical works in the Society's Library.*

This collection of books deals with the biographies of companions of the Prophet, commentators of the Qur'ān, poets, writers, traditionists and saints of the Islamic world. It consists of about 71 works, of which some comprise several volumes.

3. Chintaharan Chakravarti.—*The Society's collection of Manuscripts of the Tantrasāra in Non-Bengali Scripts.*

Though there are numerous Sanskrit works of a comparatively earlier age possessing a general interest and enjoying an all-India popularity, the provinces in comparatively later years developed provincial literatures of regional and limited interest, little known beyond their territorial borders. A special significance therefore attaches to the find of manuscripts of works of one province in places beyond its limits and specially in scripts not in use therein.

The Society's collection, made principally in Bengal, contains manuscripts in the Bengali script of a good number of works composed in other parts of the country. Manuscripts of works, produced in Bengal, copied in non-Bengali scripts, however, figure very poorly in this collection though such manuscripts are known to exist in different parts of the country.

The Society's collection of manuscripts of the *Tantrasāra* of Krsnānanda is specially interesting in this respect It is a sixteenth century work on Tantra-rituals very popular in Bengal. But the Society's manuscripts of the work are almost all in non Bengali scripts. The two complete manuscripts (4755, 11288) are in the Newari script. There are also two manuscripts in the Nāgari script (10955, 11176) containing only extracts Portions of the work are found in a mutilated form, with occasional omission intervening, in two manuscripts one (11294) in Nāgari and the other in Newari (11354) as also in a Bengali manuscript (5015)—the only one in Bengali character—where the order of the topics is different from that in the *Tantrasāra.* It is not known if the last three manuscripts belong to works based on the work of Kṛṣṇānanda like Rāmānanda's *Saṃgraha* of which there is a manuscript in the Society (II. A. 48), complete in ten chapters. It is also possible that the *Tantrasāra* along with other works borrowed from the same source which, or rather fragments of which, can be traced in these manuscripts as well as in works like the *Syāmārahasya*, sections of which (*e.g., Śavasādhanā*) closely agree with similar sections of the *Tantrasāra.*

Indian Chemical Society

An ordinary general meeting of the India Chemical Society was held on Thursday, the 4th of March 1937, at 5 p. m. in the Chemistry Lecture Theatre, University College of Science, Calcutta, with Prof. J. N. Mukherjee in the chair.

I. The following gentlemen were admitted as Fellows on having paid their first subscriptions.

(1) D. G. Walawalkar, M. Sc. Cawnpore, (2) M. A Sahoor. M. Sc, Calcutta, (3) Dr. U. Basu, D. Sc., Calcutta, (4) Dr. P. B. Sarkar, D. Sc., Calcutta.

II. The following gentlemen having been duly proposed were elected as Fellows by ballot, Dr. Sudhamoy Ghose and Rev. Father J. Van Neste, S. J., acting as scrutators.

(1) A Kamal, Calcutta. (2) R G Chatterjee, M Sc., Darjeeling. (3) Charles H Shirtcliffe Ishapore (4) S A Qureshi, B. Sc., Peshawar (5) Narendra Chandra Deb, M. Sc., Sylhet. (6) Aree Supol, B. Sc, Bangkok, Siam (7) Hemendra Prosad Samanta, M Sc., Jamshedpur (8) D P Chatterjee, M. Sc., Howrah (9) Dr R K Dutt Roy, Dr. Ing., Calcutta. (10) Sisir Kumar Guha, M Sc, Patna. (11) Munir-ud-Din, M. Sc., Lahore (12) Dr Harbans Lal Uppal, M. Sc., Ph. D., Lahore (13) Dr. Rattan Chand Hoon, M. Sc., Ph. D., Lahore. (14) Dr B McKenzie Taylor, M.B.E., Ph. D., D.Sc. F. I. C., Lahore. (15) Sampuran Das Mahant, M. Sc., Lahore. (16) Narendra Nath Chopra, M. Sc., Lahore. (17) Dr. Krishna Gopal Mathur, D. Sc., F. I. C., Lahore. (18) Mulk Raj Verma, M. Sc., Lahore (19) Dr. V. Subrahmanian, M. Sc., Ph. D., F. I. C., Lahore. (20) M. Abdul Hamid, M Sc., Bombay. (21) Manohar Lal Bhandari, M. Sc., Lahore. (22) Dr. Jogendra Chandra Bardhan, D. Sc., Calcutta. (23) Jogendra Nath Chakravarti, M. Sc., Dacca.

III. The chairman announced that the lecture as notified previously could not be delivered as Prof. P. Neogi had to leave Calcutta suddenly.

An ordinary general meeting of the Indian Chemical Society, was held on April 23, 1937, at 5 p.m. in the Chemistry Lecture Theatre, University College of Science, 92, Upper Circular Road, Calcutta, with Prof. J. N. Mukherjee in the chair.

I. The following gentlemen were admitted as Fellows after having paid their first subscriptions.

(1) A. Kamal, M. Sc. Calcutta. (2) Sisir Kumar Guha, M. Sc., Patna. (3) N. N. Chopra, M. Sc., Lahore. (4) Aree Supol, B. Sc., Bangkok, Siam. (5) Dr. R. K. Dutt-Roy, Dr. Ing., Calcutta. (6) S. A. Qureshi, B. Sc., Peshawar. (7) R. G. Chatterjee, M. Sc. Darjeeling. (8) D. P. Chatterjee, M. Sc., Howrah. (9) Dr J. C. Bardhan, D. Sc., Calcutta. (10) G. N. Banerjee, B. Sc., Bombay. (11) M. Abdul Hamid, M. Sc., Bombay. (12) Narendra Chandra Deb, M. Sc., Sylhet. (13) Dr R. C. Hoon, M. Sc. Ph. D. Lahore.

II. The following gentlemen were elected by ballot as Fellows, Dr. S. P. Raychaudhuri and Dr. D. Chakravarti acting as scrutators.

(1) Constant W. P. Van der Meyden, Cawnpore. (2) Prof. Andre Girarded, Lausanne, Switzerland. (3) Sindhu Bhusan Ghosh, Calcutta. (4) Dr. S. V. Anantakrishnan, M. A., Ph. D., A. I. C., Calcutta. (5) Bibhuti Bhusan Chaudhuri, M. Sc., Kirkee. (6) Dr Tarapada Banerjee, D. Sc, Dacca.

III. Dr. S. P. Raychaudhuri Ph.D., D.Sc., A.I.C., delivered a lecture on "The nature of laterite and lateritic soil" in the meeting. Dr. J. N. Mukherjee, Dr. S. Ghosh, Mr. S. Mukherjee and several others joined the discussion.

Letters to the Editor

Diffraction of Electrons analogous to Debye-Schearer X-ray Diffraction

Attempts have been made to diffract electrons by minute crystals oriented at random in a manner analogous to Debye-Schearer powder method. For this purpose, a very fine copper wire is used as the diffracting material which evidently consists of numerous minute crystals arranged at random. But unlike the X-ray method, the main difficulty of the experiment lies in the fact that as the wire is exposed to the beam of electrons, a black coating is at once formed on the surface of the wire. The general scattering from the tarnished surface is very strong at a small angle and consequently, the central portion of the photographic plate gets intensely blackened. The rings, therefore, appear very weak on the blackened background. Moreover the exposure for diffraction cannot be increased because of this blackening effect from the surface coating.

Another point to be noticed is that, with the highly polished wire as it is obtained from the market, diffraction rings are not obtained at all.

By using a fine copper wire of diameter 0·193 mm. with its surface slightly scratched with a sand paper, we have observed only two faint rings which are identified to be reflected from the 311 and 400 plane faces. The possible rings from 111, 200, and 220 planes do not appear on the plate. This may be explained as due to the fact that these rings fall on the region covered by amorphous scattering which is rather very strong. The measurement of the diameter of the central blackening confirms this idea.

The diameters of the two rings have been carefully measured. Since

$$\frac{\lambda}{2a} = \frac{\sin\theta}{\sqrt{h^2+k^2+l^2}}$$

where the notations have their usual significance. It follows that $\dfrac{\sin\theta}{\sqrt{h^2+k^2+l^2}}$ will be constant for the different rings for a constant voltage in the tube. The following table shows the correctness of the above expression.

Ring	diameter	Sin θ	Indices of planes $h, k, l,$	$\dfrac{\lambda}{2a} = \dfrac{\sin\theta}{\sqrt{h^2+k^2+l^2}}$
1st ring	2·42 cm.	0·0301	311	0·0091
2nd ring	2·86 cm.	0·0355	400	0·0089

In this particular case, λ is calculated to be equal to 0·0741 × 10^{-8} cm. and $\dfrac{\lambda}{2a}$ comes out to be 0·0103, taking 3·6Å (from X-ray data) as the value of a for copper. This value is a little higher than that calculated from $\dfrac{\sin\theta}{\sqrt{h^2+k^2+l^2}}$ as shown above. This slight discrepancy may be attributed to the error in the measurement of the diameter of the faint rings.

Khaira Laboratory of Physics,
University College of Science,
Calcutta.
6.5 37.

S. Chaudhuri.

The Allotropes of Sulphur—a Study by the X-ray Diffraction Method

In the previous letters [1,2] the results of X-ray analysis of several wellknown modifications of sulphur were reported. In the present letter we wish to record some interesting facts noticed during the progress of the later investigations.

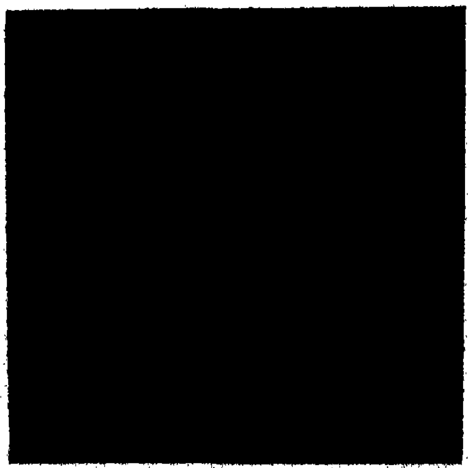


Fig. 1. White Sulphur.
Sulphur to plate distance, r=1·965 cm.

(a) White Sulphur (Fig. 1).

We have found, contrary to the prevalent idea based on physico-chemical analysis, that white sulphur prepared by the hydrolysis of sulphur monochloride ($2S_2Cl_2+2H_2O=$

$4HCl + SO_2 + 3S$) is distinctly crystalline and produces a very sharp and well-defined diffraction pattern. But the peculiarity is that the pattern bears no similarity to those shown by α-sulphur, the crystalline modification hitherto known as the only variety stable at the ordinary temperature.

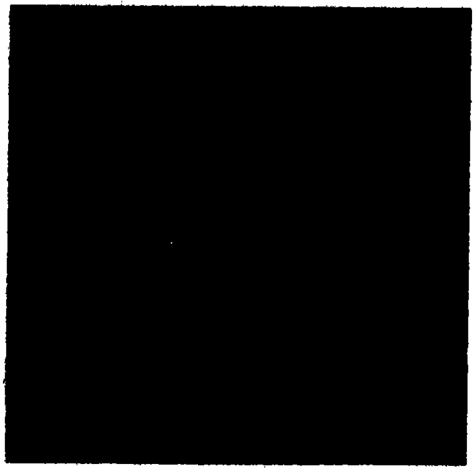


Fig. 2. Rhombic or α-Sulphur
at 30°C (room temperature). $r = 1{\cdot}965$ cm.

Further, it is interesting to note that a complete change of its structure may by effected by heating it at 88°C for 36 hours The ring-system in this case indicates an α-sulphur structure. Both of these two types of white sulphur are insoluble in carbon disulphide.

(*b*) Hardened plasti sulphur :—

Sulphur in this state is almost totally insoluble in carbon disulphide, but as reported previously[2], it is found to possess a crystalline structure exactly similar to that of ordinary rhombic sulphur or α-sulphur. This structure is retained by it, unlike white sulphur, even after a prolonged heating for more than 48 hours at 90°C. But this heat treatment rendered it completely soluble in CS_2 and highly friable.

No satisfactory explanation has yet been suggested by anybody regarding the solubility and the insolubility of sulphur. Further investigations, here in progress, are supposed to elucidate the point.

(*c*) Effects of heat on α-sulphur :—

(i) Asterism (Fig. 3).

To observe these effects, the sample under examination was maintained, throughout the whole period of exposure, at the desired temperature by an electric heater. Practically no change in the diffraction pattern could be detected at temperatures up to 75°C. Above 80°C, the sharpness of he rings is marred by the appearance of radial lines intersecting the rings orthogonally. This phenomenon, "asterism" as it is called, is observed in the photographs taken with metal foils where the crystals are strained by the process of rolling.

Now in the case of an enantiomorphic crystalline substance like sulphur, we may very well imagine that near about the transition point, the process of structural transformation which consists in re-orientation of the various crystal planes may itself form sufficient mechanical strain giving rise to asterism.

The transition point of $S\alpha \rightleftharpoons S\beta$ has been located by the chemists near about 95°C. But we think that the transformation starts at about 80°C, when we first notice the sterism. An elevation of temperature accelerates the velocity of transformation $S\alpha \longrightarrow S\beta$, and that at 95°C it is sufficient for detection by physico-chemical means.

According to the above idea about the origin of asterism, one should expect more prominent asterism effects when sulphur is kept at higher temperatures, for a greater tendency for transformation at higher temperatures means a stronger force producing the strain. And that is what we have really observed above 100°C (Pl. 104 sulphur at 104°C).

(*ii*) Growth of size of the crystals (Fig. 4).

If the same sample of sulphur be kept at a temperature of about 80°C or above, the diffraction pattern taken during the first twelve hours of heating primarily shows the asterism effect as its only peculiarity and except for this, the general appearance of the pattern is preserved. But the photographs taken after twelve hours or later show in asterism a large number of intense dots arranged on the

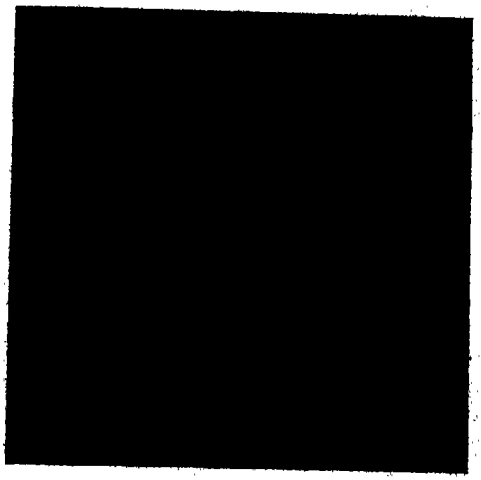


Fig. 3, Asterism.
Sulphur at 104°C [1st. Stage].
$r = 1{\cdot}93$ cm

rings. The dots become more numerous and the rings less intense, as the time of heating progresses. Ultimately, there can hardly be found any ring, but only dots arranged apparently at random. (Fig. 4 Sulphur at 104°C. Period of heating exceeding 40 hours). This we ascribe to the combined effect of the mechanical strain and the growth of size of the crystals. Lately we have had some other evidences for the growth of sulphur crystals in the solid state. The detection of a monoclinic pattern is also rendered impossible by these two effects. Recently we have been able to obtain the diffraction rings due to sulphur in the liquid state at different temperatures. In each case only two broad rings have been noticed.

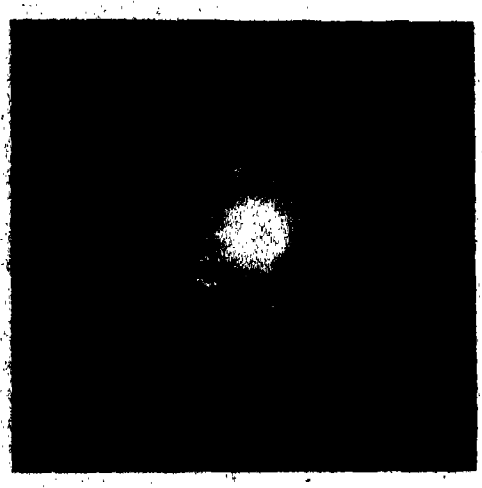


Fig. 4. Sulphur at 104°C. Period of heating exceeding 40 hours. $r = 1\cdot93$ cm.

The results will be published in detail elsewhere.

Khaira Laboratory of Physics,
University College of Science,
92, Upper Circular Road,
Calcutta.
22.4.37.

R. Das.
K. Ray.

1. Das, SCIENCE & CULTURE, *1*, 784, 1936.
2. Das & Ray, SCIENCE & CULTURE, *2*, 108, 1936.

X-ray Analysis of the Structure of Jute Fibres

An extensive chemical analysis carried out by Dr T. K. Chaudhuri and his collaborators has established that the chief constituents of the jute fibres are cellulose and lignin[1]. Chemically, cellulose is now held to be a polymer of anhydro-β-glucose i.e. $C_6H_{10}O_5$ $(=C_6H_{12}O_6-H_2O)$. These glucose residue units are linked up by covalent bonds to form the cellulose chain (fig. 1).

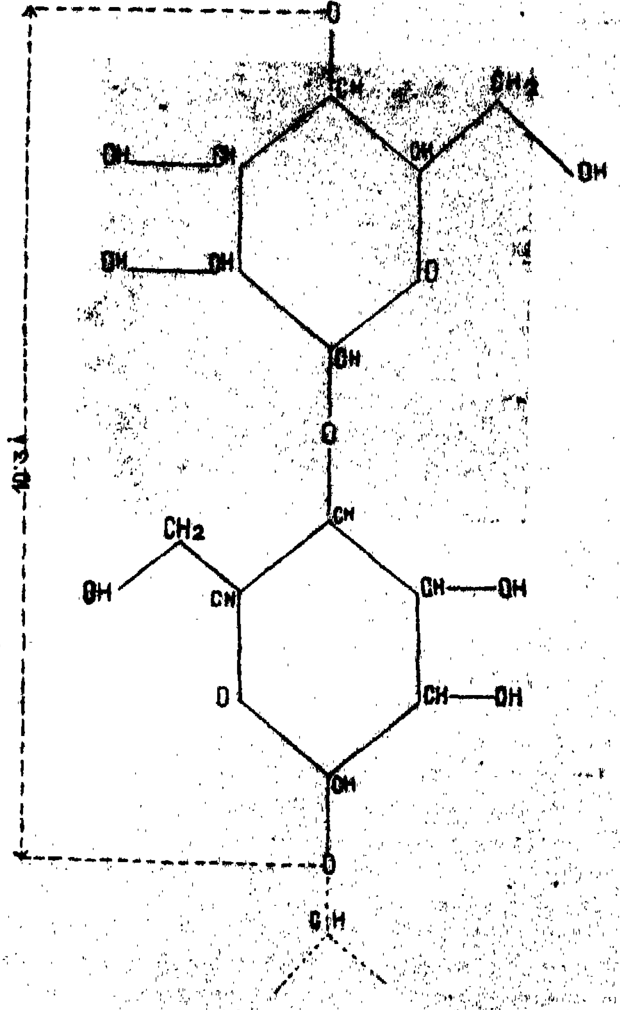


Fig. 1.

In the present investigation several well-shaped jute fibres were sorted out, cut off into suitable sizes and re-arranged with their fibre axes parallel to each other. Two different photographs on plane photographic plates have been obtained with fibres arranged in the above fashion: one with fibre-axes perpendicular and the other with the fibre axes parallel to the incident X-ray beam.

As Fig. 2 illustrates, the radiograph in the first case is similar to a rotation photograph of a simple crystal rotated about one of its main axes. In the present case it may therefore be concluded from the very appearance of the photograph that the axes of the jute fibres coincide with one of the zone-axes of the crystal units building up the fibres. As a large number of fibres with all possible azimuthal orientations relative to the fibre axes were used, a rotation pattern has been possible, without rotating the fibres at all.

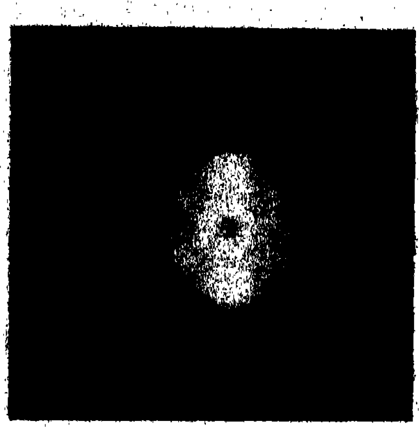


Fig. 2.

Measurements and calculations of a preliminary nature indicate that the interval at which the pattern is repeated along the fibre-axes is about 10·29Å. This value agrees with the length of the b-axes of natural cellulose, as determined by Polanyi[2] and others[3],[4]. They have identified the space group to be $C_2^2, P2_1$ and found out the cell to have $a=8.3$, $b=10.3$, $c=7.9$ and $\beta=84°$.

The well-defined character of the hyperbolic layer-lines in the present case indicates that the arrangement of patterns is fairly regular over a large number of units in the direction of the fibre axis, whereas the spreading out of the spots show that the structure is not so flawless in directions perpendicular to it.

The radiograph obtained with the fibres placed with their axes parallel to the X-ray beam, exhibits a ring system resembling a powder pattern.

The results of the complete and systematic structural analysis will shortly be published.

Khaira Laboratory of Physics,
University College of Science,
92, Upper circular Road, S. R. Das.
Calcutta.
15. 5. 37.

1. Jute fibre—P. B. Sarkar, *Sc. & Cul.* *1*, 308, 1935.
2. M. Polanyi—*Naturwiss.*, *9*, 288, 1921.
3. H. Mark and K. H. Meyer—*Zs. Phys. Chem. B*, *2*, 115, 1929.
4. W. T. Astbury and T. C. Marwick, *Nature*, *127*, 12, 1931.

[illegible]

In continuation of our work on Raman effect in inorganic compounds, very recently, we investigated the Raman effect in boric acid in solution and a few borates using the usual orthodox experimental arrangement. In the case of the saturated solution of the acid* we observed the following three frequencies, namely 515, 872, 986 Cm⁻¹, whereas in the case of the dilute solution* we observed the frequencies 710, 872, 909 and 1340 Cm⁻¹. In the case of the sodium borate (solid) we found the frequencies 714, 911 Cm⁻¹.

Presumably it might be assumed that the molecules of boric acid and the borate ion have a plane triangular configuration with symmetry D_{3h} and that the frequencies 515, 872, 986 be attributed to the molecule $B(OH)_3$ and 710, 909 and 1340 to the ion BO_3.

It might be mentioned here in passing that Sen and Sen Gupta[1] and Sen[2] attributed the frequencies 715, 909 and 1333 to BO_3 ion and 675, 869, 990 to $B(OH)_3$ on the strength of their infra-red absorption data. The agreement seems to be fairly good except in the case of the 695 Cm⁻¹.

Further work is in progress and the details will be published in due course.

Physics Laboratory,
Dacca University. S. M. Mitra.
2. 5. 37

1. *Ind. J. Phy.*, *9*, 433, 1935.
2. *Ind. J. Phy.*, *10*, 9, 1937.

* A little KI was added to remove the continuous radiations.

Chemotherapeutic Studies on Sulphanilamides

The recent observation[1] on the capability of a simple compound like p-aminobenzenesulphonamide (sulphanilamide) in rendering the blood antiseptic to haemolytic streptococci when administered by the mouth, has aroused a great interest on the problem of chemotherapy of any bacterial infection. The action of acriflavine or similar other antiseptic is purely direct and local, whereas the action of this new drug is being found to be a quite different one. Most probably it is the first time that a drug has been found to possess a specific bactericidal activity even when introduced into a body *via* the alimentary tract. Further, the demonstration[2] of the therapeutic activity of red azo dye "Prontosil Soluble" and orange azo dye "Red Prontosil" as being due to the reduction of the above compounds to sulphanilamide itself in the system, points to a particular specificity of the drug. Unfortunately, however, it is not absolutely non-toxic as it often produces sulphaemoglobinaemia[3] and consequently would be more dangerous if prescribed to anaemic patients.

Accordingly, it would now be not out of interest, if an attempt be made for the preparation of similar other sulphanilamides.

So far, p-acetylaminobenzenesulphonylchloride had been reacted with such amino-compounds which are again known to possess either antiseptic, analgesic or a local anaesthetic action and the resulting reaction products had been hydrolysed by dilute hydrochloric acid to the corresponding derivatives of the type, $NH_2 \cdot C_6H_4 \cdot SO_2 \cdot NHR$, where $R = C_6H_4 . CO_2Et$ (p), $C_6H_4 . OCH_3$ (p) and an acridine nucleus. In the reaction between the above sulphonyl chloride and δ-diethylamino-butylamine, the compound, p-aminobenzene sulphon - (δ- diethylaminobutyl) -amide, was, however, directly obtained as its hydrochloride. This salt is readily soluble in water and easily crystallizes out from boiling alcohol in shining needles, m. p. 172°.

Work for finding out the protective action of the above compounds against streptococcal infection on mice is in progress.

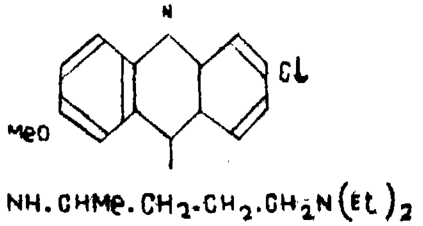
Research Laboratory,
Bengal Immunity,
Barnagore Calcutta.
16. 4. 37

A. K. Choudhury.
U. Basu.

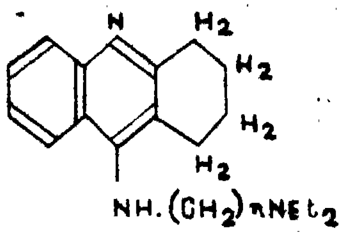
1. Buttle, Gray and Stephenson, *Lancet*, i, 1286, 1936.
2. Fuller, *Lancet*, i, 194, 1937; Tre'fouel, Nitti and Bovet, *C. R. Soc. Biol. Paris*, *120*, 736, 1935.
3. Discombe, *Lancet*, i, 626, 1937; cf., Colebrook and Kenny, *Lancet*, i, 1279, 1936; Foulis and Barr, *Brit. Med. Jour.*, i, 445, 1937.

Chemotherapeutic Studies in the Bz-tetrahydro Quinoline Series. Part II. Tetrahydro acridine Derivatives as Antimalarials

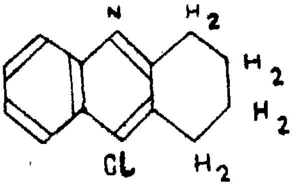
The dihydrochloride of 2-chloro 5 (ω-diethyl amino isoamyl) amino 7-methoxy acridine (I) better known as 'Atebrin', has a powerful action on all asexual forms of the malarial parasites. It is well tolerated by children and pregnant women and finds a considerable application in cases of black water fever. But being a dye, it stains the skin of the patient yellow and often gives rise to certain toxic symptoms. Recently[1], a good deal of attention has been given for the syntheses of various other acridine derivatives of the above type, having particularly a dialkylamino alkyl amino side chain in position 5. It may be here assumed that in a reduced acridine derivative of the type (II) a compound may be found where this characteristic dyeing property would be absent and which may be more safely administered as reduction is generally believed to diminish the toxicity of a compound. Of course, very little is known up till now about the physiological activity of any hydrated acridine derivative; still, however, a study of the above nature would at least afford an interesting analogy with the corresponding reduced compounds from quinolines and pyridines.



(I)



(II)



(III)

Accordingly, several 5-chloro-1 : 2 : 3 : 4-tetrahydro acridines (III) have been prepared by reacting the tetrahydro acridones synthesized according to the method of Sen and Basu[2], with a mixture of phosphorus oxy-and pentachlorides. These chloro compounds readily react with dialkylaminoalkyl amines to give rise to the compounds of the type (II). Thus, for example, ethyl cyclohexanone 2-carboxylate and p-anisidine gave 7-methoxy-1 : 2 : 3 : 4-tetrahydro acridone, m. p. 295°, which on treatment with phosphorus chlorides yielded 5-chloro-7-methoxy-1 : 2 : 3 : 4: tetrahydro acridine, m p. 122°. The chloro compound on heating with diethylamino propyl amine was converted to a viscous mass from which the dihydrochloride of 7-methoxy-5 (diethylamino propyl) amino-1 : 2 : 3 : 4 tetrahydro acridine, m. p. 228-229° was easily isolated. Similarly, diethylamino butyl amine gave with the above chloro compound the dihydrochloride of 7-methoxy-5 (diethylamino butyl) amino-1 : 2 : 3 : 4-tetrahydro acridine, m. p. 193-194°. All the hydrochlorides thus obtained, are found to be almost colourless bitter substances. They are highly soluble in water but can be easily crystallized from a mixture (1 : 1) of alcohol and ether.

The other characteristics of the compounds are being studied and the details of the paper would be published elsewhere.

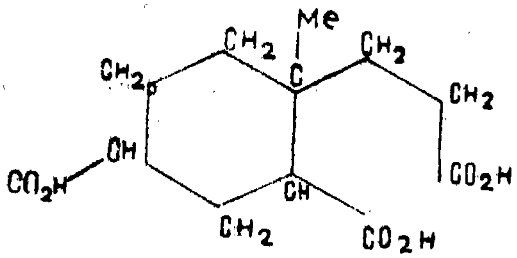
Research Laboratory,
Bengal Immunity, Barnagore,
Calcutta.
4.5.37

S. J. Dasgupta.
U. Basu.

1. Magidson and Grigorovski, *Ber.*, *69*. 396, 537, 1936.
2. Sen and Basu, *J. Indian Chem. Soc. 7*, 435, 1930.

Synthesis in the Selinene Group

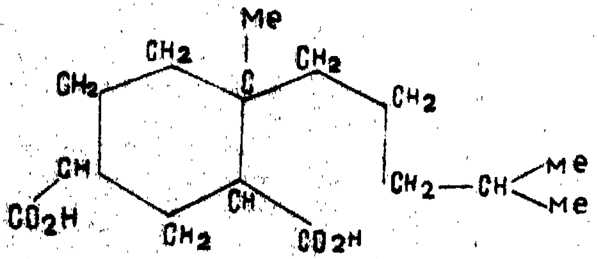
By the oxidative degradation of *β*-selinene Semmler[1] isolated a tricarboxylic acid $C_{12}H_{18}O_6$, m. p. 188°, which was correctly represented as (I) by Ruzicka and Stoll[2].



(I)

Preliminary experiments carried out with the object of preparing this acid synthetically are now recorded.

β-Methyl-*β*-isohexylglutaric acid[3] was first converted into the anhydride, b.p. 157°/4 m. m.; this was then reduced with sodium and alcohol to the related lactone, b.p. 145°/7 m. m. which was transformed into ethyl *β*-methyl-*β*-isohexyl-*δ*-bromo valerate, b .p. 140°/4 m. m. through the agency of phosphorus pentabromide. The bromo-ester readily reacted with ethyl sodiomalonate giving the expected tricarboxylic ester, b.p. 195°/4 m. m. Sodium-condensation of the latter yielded the cyclic-ketoester, b.p. 170°/5 m. m. which on reduction with sodium amalgam gave the corresponding hydroxy-ester, b.p. 178°/4 m. m. The related hydroxy-dicarboxylic acid on successive treatment with hydrobromic-acetic acid and zinc dust gave the interesting dicarboxylic acid (II), as a gum. This substance could not be resolved into pure stereo-isomers and on oxidation with chromic acid furnished a tribasic acid (purified through the triethyl ester), which could not be obtained in a solid state even when left in an evacuated desiccator for 18 months.



(II)

The work is being extended to the appropriate *ω*-alkoxy-alkyl methyl ketones in order to prepare the solid tricarboxylic acid and its higher homologue. The results will be published elsewhere.

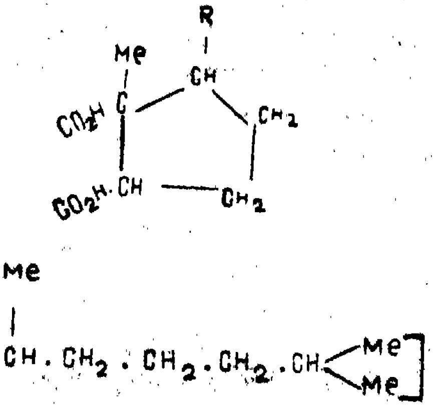
University College of Science,
Scottish Church College,
Calcutta.
10. 5. 37.

J. C. Bardhan.
S. K. Banerji.

1. *Ber.*, *46*, 600, 1913.
2. *Helv. Chim. Acta.*, *6*, 846, 1923.
3. Guareschi, *Gazzetta*, *49*, i, 124, 1919.
4. Windaus und Neukirchen, *Ber*, *52*, (B), 1917, 1919.

Preliminary Experiments on the Synthesis of Wieland's Tricarboxylic Acid, $C_{13}H_{20}O_6$

The synthesis of the monocyclic tricarboxylic acid, $C_{13}H_{20}O_6$, isolated by Wieland and his coworkers[1] still remains to be accomplished. For some time past we have been endeavouring to devise a suitable method for the synthesis of this important acid and in continuation of the work recorded in the preceding communication we have made certain preliminary experiments with a view to synthesize the dicarboxylic acid (I), since it is to be expected that this acid on oxidation with chromic acid according to the well-known method of Windaus and



$$R = \left[\overset{\overset{Me}{|}}{\cdot C}H \cdot CH_2 \cdot CH_2 \cdot CH_2 \cdot CH\begin{smallmatrix}Me\\Me\end{smallmatrix}\right]$$

(I)

his coworkers[2] should give the tricarboxylic acid or a stereo-isomer.

6-Methyl-2-iodo-heptane[3] readily condensed with ethyl sodio-aceto-acetate giving ethyl 1-acetyl-2:6-dimethyl heptane-1-carboxylate, b.p. 113°/6 m. m. The sodio-derivative of the latter on digestion with ethyl bromoacetate furnished ethyl 2-acetyl-3:7-dimethyl octane-1:2-dicarboxylate. b.p. 165-67°/4 m. m, which on hydrolysis in the usual way gave a ketonic acid. The latter on esterification formed ethyl 2-acetyl-3:7-dimethyl octane-1-carboxylate, b p. 130-32°/4 m. m.

Ethyl 1-acetyl-2:6-dimethylheptane-1-carboxylate described above on condensation with ethyl potassio-cyanoacetate gave the unsaturated-cyanoester, b.p. 185°/7 m. m. which smoothly added the elements of hydrogen cyanide with the formation of the saturated-dicyanoester, b.p. 205°/7 m. m. The latter is also formed in a poorer yield when the cyanohydrin of the substituted β-ketoester is allowed to react with ethyl sodio-cyanoacetate.

These experiments are being actively pursued in order to obtain the dicarboxylic acid (I) and its near relatives. In this connection we desire to record our best thanks to Sir P. C. Ray and Prof. P. C. Mitter, for their keen interest in this work.

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Calcutta.
10. 5. 37.

J. C. Bardhan.
N. C. Ganguli.

1. *Z. Physiol. Chem. 134*, 276, 1924 : *ibid., 216*, 91, 1933
2. *Z. Physiol. Chem., 117*, 146, 1921,
3. Clarke, *Amer. Chem. Jour., 31*, 113, 1909.

On the Discovery of Petroleum near Dandot, Jhelum District, Punjab

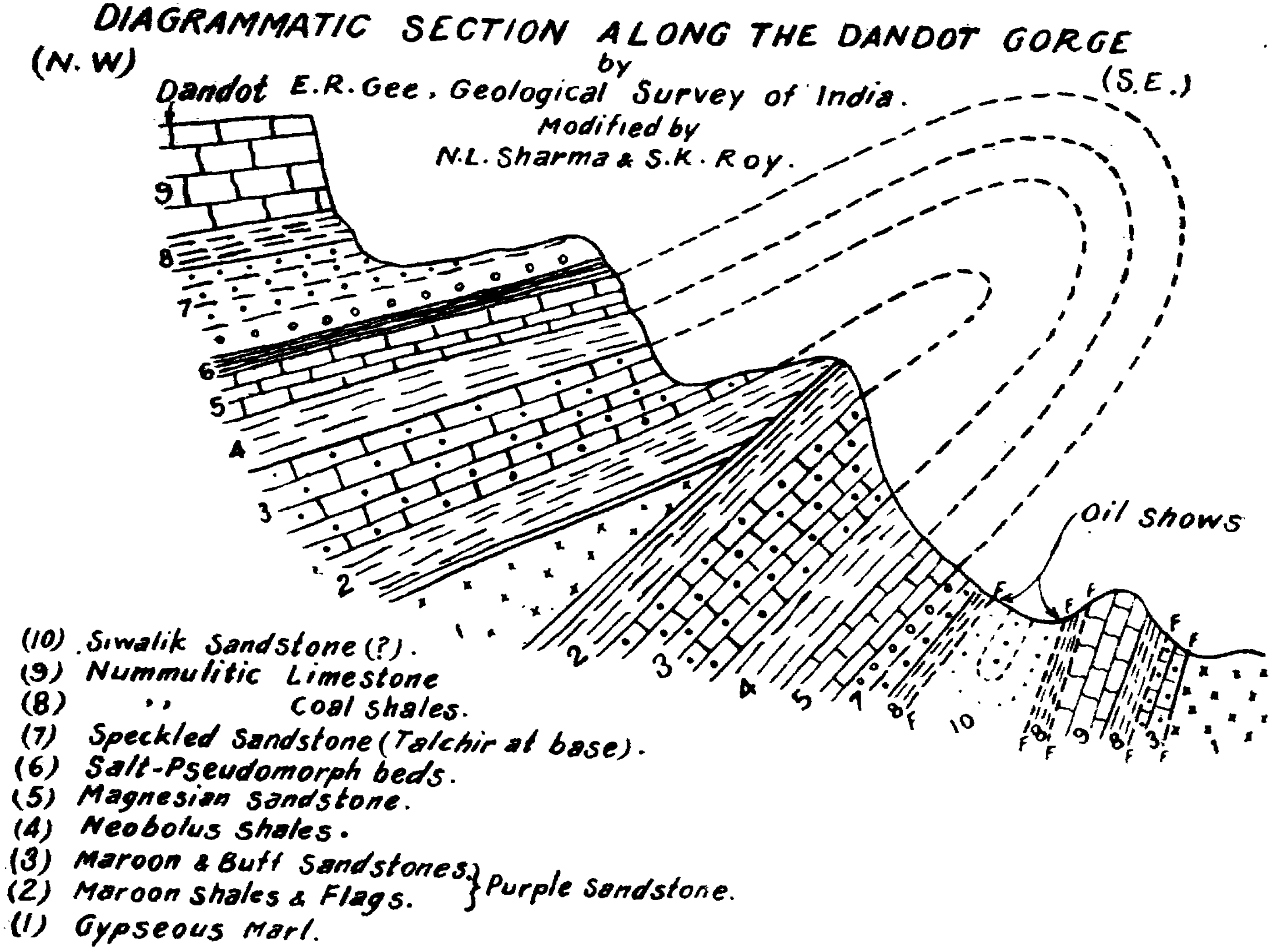
In November 1935, III & IV Year Geology students of the Indian School of Mines had an excursion to the Kangra area and the Punjab Salt Range. We could also include therein a short visit to the Khaur oil-field. Mr Gee of the Geological Survey of India was kind enough to suggest to us the geologically important localities to be visited in the Salt Range; and Mr Evans of the Burma Oil Co. kindly sent his assistant Mr W. B. Metre, one of our ex-students, to show us the important geological sections in the western portion of the Range. We are greatly indebted to Messrs Gee and Evans for their kind help.

During one of the excursions two outcrops of gray medium-grained sandstones smelling strongly of petroleum were discovered in the Dandot gorge, near Khewra Salt Mines, Punjab. One of the outcrops was so much impregnated with oil that it looked from a distance like carbonaceous sandstone. The percentage of oil in this sandstone, as kindly determined by Prof. Forrester of this Institution, is 0.5. The two outcrops of oil-bearing sandstone occur in the main gorge due south of Dandot at a point about ¼ mile S.S.W. of the hill marked 1340 on the 1"=1 mile topographical sheet No. 43 D/14 (Jhelum and Shahpur Districts). Petroleum was not reported before from this part of the Salt Range. And although the present find might not be of any immediate commercial importance it is undoubtedly an interesting clue which might eventually lead the great geologists of the oil companies to the discovery of large pools of oil in this part of the Punjab. The discovery of this oil-show has been reported to the Director of the Geological Survey of India and to Mr P. Evans, the senior Geologist in India of Messrs Burma Oil Co. Mr Evans has since visited the place.

A *geological section of Dandot gorge near Khewra* where this oil-show has been discovered is given below; *incidentally, it affords a good illustration of over-folding* (See Fig. next page).

Indian School of Mines,
Dhanbad.
10.4.37

S. N. Ray.
S. K. Roy.
N. L. Sharma.



DIAGRAMMATIC SECTION ALONG THE DANDOT GORGE
by
E.R. Gee, Geological Survey of India.
Modified by
N.L. Sharma & S.K. Roy.

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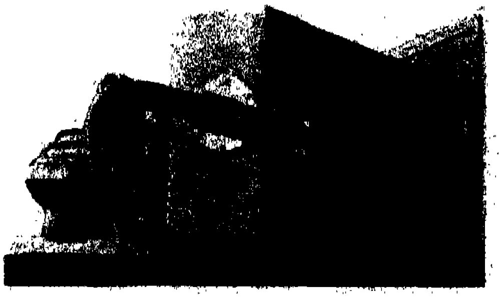

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